VERTICAL DRIVE SHAFTS AND ASSOCIATED APPARATUS REQUIREMENTS AND ADJUSTING PROCEDURES

1. GENERAL

1.01 This section covers vertical drive shafts and associated apparatus (including Nos. 1A, 1B, 1E, 1F, 1G, and 1H and 10-type and No. 13A bearings, 1-, 9-, and 11-type shafts, eccentric couplings and the No. 100A adapter).

1.02 This section is reissued to incorporate material from the addendum in its proper location. In this process marginal arrows have been omitted.

1.03 Reference shall be made to Section 020-010-711 covering general requirements and definitions for additional information necessary for the proper application of the requirements listed herein.

1.04** ***Asterisk: Requirements are marked with an asterisk (*) when to check for them would necessitate the dismantling or dismounting of apparatus, or would affect the adjustment involved or other adjustments. No check need be made for these requirements unless the apparatus or part is made accessible for other reasons or its performance indicates that such a check is advisable.

1.05 ***One discharge of oil*** for the purpose of this section is the amount of oil discharged from the No. 431A oil gun when the piston is depressed to the limit of its stroke.

1.06 ***New and Old Type Ball Bearings:*** The old type or Schatz ball bearing is distinguished from the new type or New Departure ball bearing by having an extension of the sleeve of the inner race, which extends below the bearing proper while the sleeve of the New Departure ball bearing does not extend below the bearing proper.

1.07 The term "ball bearings" used herein applies to Nos. 1A, 1B, 1E, 1F, 10A and 10B bearings having ball bearing units.

1.08 The term "graphalloy bearings" used herein applies to Nos. 1G, 1H, and 13A bearings and to Nos. 1A, 1B, 1E and 1F bearings having graphalloy bushings.

2. REQUIREMENTS

2.01 ***Cleaning:*** The exterior of the bearing brackets, the vertical shafts adjacent to bearings and the driving and driven discs shall be cleaned when necessary in accordance with approved procedures.

2.02 ***Lubrication***

(a) ***Ball bearings*** shall be adequately lubricated with KS-6438 oil (cylinder oil). When lubrication is necessary, one discharge of lubricant shall be applied.

(b) ***Graphalloy bearings*** shall not be lubricated.

(c) ***Couplings Used with 33, 34, 45, 46, 47, 48, and 1034 Type Drives Only*** (Namely, those drives which are not equipped with coupling guards) Fig. 1(A):

(1) Prior to turnover of a drive to the telephone company, whenever coupling parts are replaced or the coupling disas-

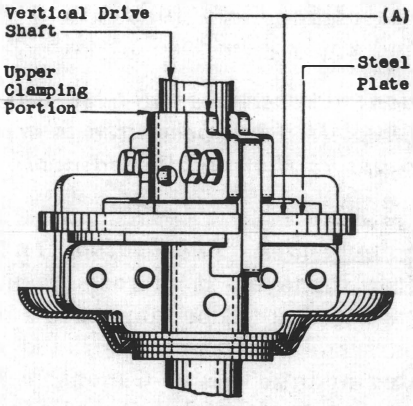

Fig. 1 – Eccentric Coupling

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sembled and cleaned, the area of the coupling plates which contact each other shall be completely covered with a film of KS-6438 oil.

(2) After turnover, the coupling shall be adequately lubricated with KS-6438 oil. When lubrication is necessary, two discharges of the oil shall be applied to the upper surface of the steel plate and one discharge to the vertical drive shaft at the upper clamping portion while the shaft is revolving. The amount of lubricant used at any time shall not be sufficient to cause it to flow off the plates.

Note: The above drives may be identified as those used on the following frames.

33, 34 and 1034 Types	Gear Reduction Type — used on later type sender frames and some miscellaneous frames.
45 and 46 Types	Friction Roll Type — used only on call distributing "B" link frames.
47 and 48 Types	Friction Roll Type — used only on sender tandem link frames

(d) ***Couplings Used With All Other Drives*** (namely, those drives which are ordinarily equipped with coupling guards): When the associated drive is first put into operation by the installation department, the parts shall be adequately lubricated with ***KS-2245 oil*** (gear case oil) in the same manner as covered in (c). No further lubrication of these couplings should be necessary because subsequent lubrication is accomplished automatically by causing the gear case oil (KS-2245) in the drive to be fed to the coupling. If, however, there are evidences of impaired lubrication, clean the parts and apply gear case oil (KS-2245).

Caution: Never use KS-6438 oil on these couplings. If it has been used in error, clean the coupling thoroughly and apply KS-2245 oil.

(e) ***Recommended Lubrication Intervals:*** After turnover, it is recommended that the parts listed in (a) be lubricated at intervals of 2 years and that the parts listed in (c) be lubricated at intervals of 6 months. These intervals may be extended if periodic inspections have indicated that local conditions are such as to insure that (a) and (c) will be met during the extended intervals.

2.03 ***Record of Lubrication:*** During the period of installation, a record shall be kept by date of the lubrication of the ball bearings and eccentric couplings and this record shall be turned over to the telephone company with the equipment. If no lubrication has been done, it shall be so stated.

2.04 ***Grip of Schatz Bearing Sleeve:*** Fig. 2(A) — The inner sleeve of any Schatz bearing shall not slip on the vertical drive shaft when the shaft is in normal operation.

Gauge by feel.

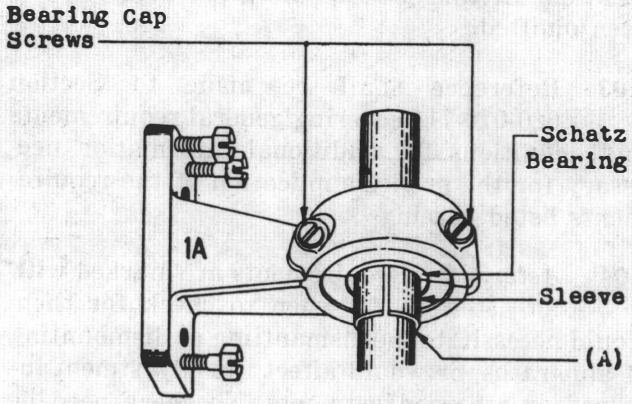

Fig. 2 – Schatz Bearing

2.05 ***Mounting of Bearing Brackets***

(a) ***All Bearings Except No. 13A Bearings:*** The bearing brackets shall be securely fastened to the frame.

Gauge by feel.

(b) ***No. 13A Bearings:*** The bearing bracket shall be securely clamped to the associated mounting bracket.

Gauge by feel.

Caution: It is not permissible to move any mounting or adjusting screws or clamping bolts when checking for this requirement without rechecking requirements 2.06, 2.07, and 2.11 to determine that the bearing is not thrown out of alignment.

2.06 *Location of Shafts and Bearings*

(a) ***Front to Rear Location of Vertical Drive Shaft Associated With Sequence Switches:*** The distance between the centerline of the vertical drive shaft and the centerline of each sequence switch cam shaft shall be within the limits specified in the following table. Use the No. 120A gauge as covered in (e).

FRAMES	MAX DEVIATION REAR	FRONT
High Usage — Long Shafts — Fig. 3(A) (see note 1)	1/32″	1/32″
High Usage — Short Shafts — Fig. 3(B) (see note 2)	0″	1/16″
Shafts in Other Frames — Fig. 3(C)	3/32″	3/32″

Note 1: This requirement applies to the following high usage frames with long shafts.

Subscriber Sender
Subscriber Sender Link
B Sender Link
Tandem Sender
District (zone register switch only)
Decoder Test
Tandem Decoder Test
Full Selector Link
Operators Link
Local Test Desk Test Selector

Note 2: This requirement applies to the following high usage frames with short shafts.

Subscriber Sender Test
B Sender Test
Tandem Sender Test
District Selector Test
Tandem District Test
3-Wire Office Test
Incoming Selector Test
Final Selector Test
Final Multiple Test Line

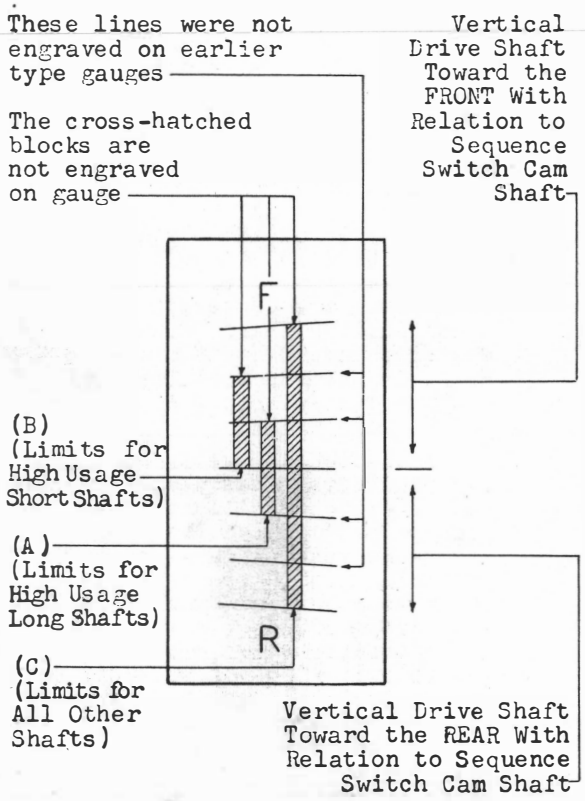
These lines were not engraved on earlier type gauges
The cross-hatched blocks are not engraved on gauge
Vertical Drive Shaft Toward the FRONT With Relation to Sequence Switch Cam Shaft
F
R
(B) (Limits for High Usage Short Shafts)
(A) (Limits for High Usage Long Shafts)
(C) (Limits for All Other Shafts)
Vertical Drive Shaft Toward the REAR With Relation to Sequence Switch Cam Shaft

Fig. 3 - Showing Areas within which Indicator of No. 120A Gauge must lie when a Vertical Drive Shaft is properly located with respect to the Sequence Switch Cam Shaft for the three different conditions covered by Requirement 2.06(a).

(b) Fig. 4 (A) - Front to Rear Location of Vertical Drive Shaft Associated with Power Driven Rotary Selectors: The centerline of the vertical drive shaft shall be aligned with the centerline of each power driven rotary selector. Any deviation of the vertical drive shaft from this alignment shall be toward the front of the shaft and shall be Max. 1/16". Use the No. 159A Gauge as outlined in (f).

(c) Right to Left Location of Shafts Associated with Sequence Switches and Power Driven Rotary Selectors: (Applies at time of turnover to the Telephone Company) - The right to left location of the vertical drive shaft shall be such that the sequence switch or power driven rotary selector will meet the requirement covering clearance between mounting screws and right hand end of the slots in the sequence switch frame or power driven rotary selector frame mounting straps as specified in the section covering sequence switches.

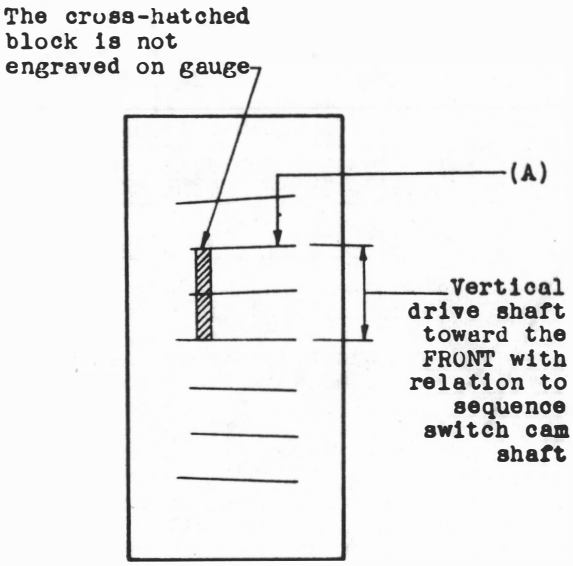
The cross-hatched block is not engraved on gauge
(A)
Vertical drive shaft toward the FRONT with relation to sequence switch cam shaft

Fig. 4 - Showing Area within which Indicator of No. 159A Gauge must lie when a Vertical Drive Shaft is properly located with respect to a Power Driven Rotary Selector

(d) Location of Shafts Associated with Interrupters Exclusively: The bearings nearest the top and bottom reference holes shall be so located that:

(1) Fig. 5 (A) - The perpendicular distance between the centerline of the vertical drive shaft and the centerline of the reference hole is 2-11/64" ± 1/32".

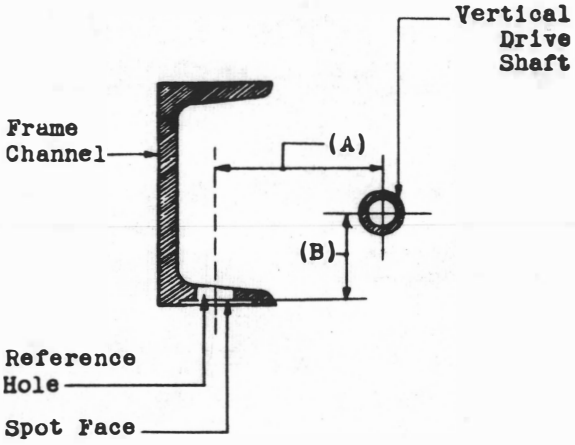

Fig. 5 - Reference Hole in Frame Channel

(2) Fig. 5 (B) - The perpendicular distance between the spot face of the channel and the centerline of the vertical drive shaft is 1-1/4" ±1/32" measured at a point close to the bearing.

Note: When necessary to check requirements (d1) or (d2), the W.E.Co. R-2447 gauge may be used.

(e) Method of Checking Shaft Location Using the No. 120A Gauge: To check the location of the vertical drive shaft with respect to the sequence switches proceed as follows: When checking the shaft opposite an "A" type sequence switch, move the slider of the No. 120A gauge to the left as far as possible or if the shaft is checked opposite a "B" type sequence switch, move the slider to the right as far as possible. Place the gauge in position with the "V" prong of the slider on the bearing pin and the large "V" prong on the driven disc spacing collar as shown in Fig. 6. There may be cases where this will cause the prong on the left to touch the "A" cam. In these cases, move the gauge slightly to the left until it clears the cam. Hold the gauge so that it is horizontal. The plunger of the gauge should rest against the vertical drive shaft and the indicator will show the front to rear location of the vertical drive shaft with respect to the sequence switch. When checking shafts where the permitted deviation in alignment is max. 1/32", the shaft is satisfactorily located if the indicator is on the centerline or not beyond the first line from the centerline or an imaginary line 1/3 the distance from the centerline. (See Fig. 3) When checking shafts where the permitted deviation in alignment is max. 3/32", the shaft is satisfactorily located if the indicator is within the outside lines.

When checking vertical drive shafts (short shafts) associated with 15 sequence switch positions or less and not equipped with 10 type bearings, note that the gauge reading as shown in Fig. 3 indicates that the centerline of the shaft is on or in front of the centerline of the sequence switches. The shaft is so positioned in order to reduce the possibility of the drive shaft climbing when associated sequence switches are operated simultaneously. In the case of the longer shafts this is not necessary because the weight of the shaft tends to prevent its upward movement.

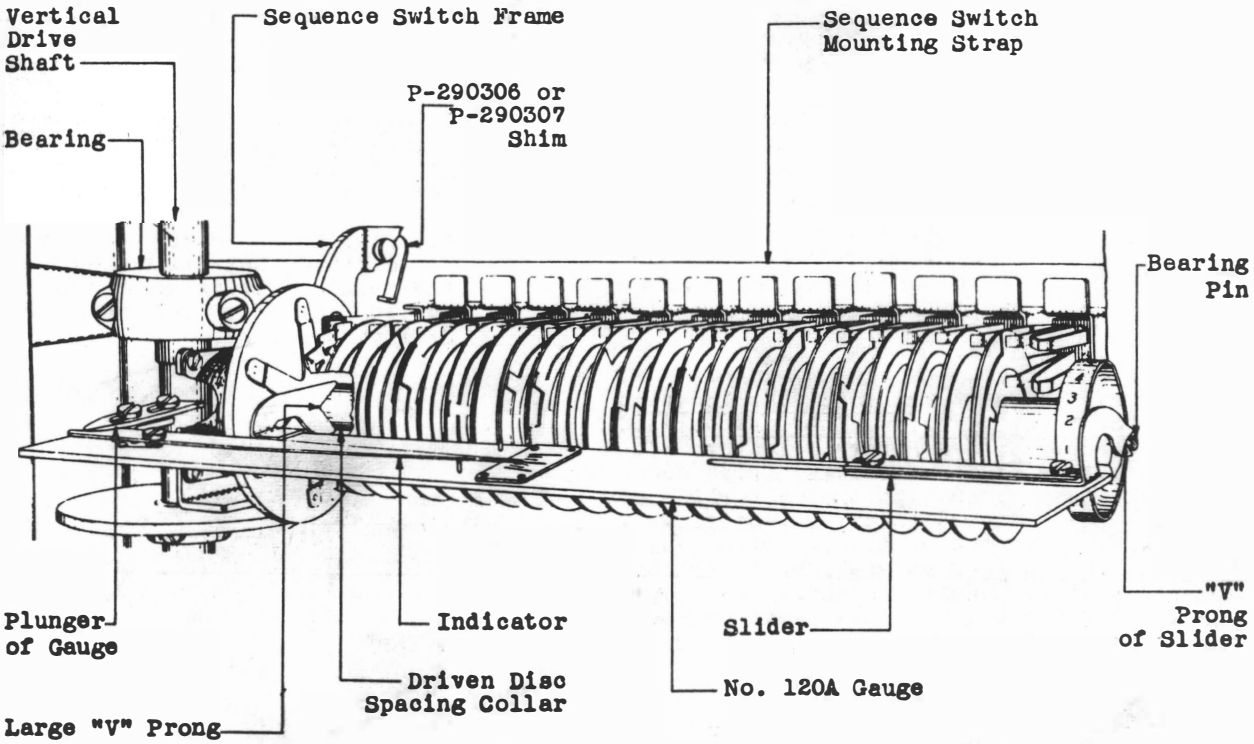

Fig. 6 - Method of Checking Location of Shafts and Bearings

(f) Method of Checking Shaft Location Using the No. 159A Gauge: To check the location of the vertical drive shaft with respect to the power driven rotary selectors, proceed as follows. Move the slider of the No. 159A gauge to the left as far as possible. Hold the gauge with both hands and insert the finger on the left side of the gauge into the shaft bearing hole of the selector. Place the gauge in position with the "V" prong of the slider on the bearing pin. There may be cases where it will be necessary to move the slider toward the right so that the "V" prong will engage the bearing pin. Hold the gauge so that it is horizontal. The plunger of the gauge should rest against the vertical drive shaft and the indicator will show the front to rear location of the vertical drive shaft with respect to the power driven rotary selector. The shaft is satisfactorily located if the indicator is on the centerline or not beyond the second line from the centerline toward the selector.

2.07 Alignment of Vertical Drive Shaft Bearings: The bearings shall be not more than 1/64" from true alignment.

To check the location of the bearings proceed as follows: Attach the proper cord holding details to the shaft as shown in Fig. 8, one detail above or at the top bearing and one at the bottom end of the vertical drive shaft. Stretch the R-1313 fish line tightly between the two supports as shown in Fig. 8.

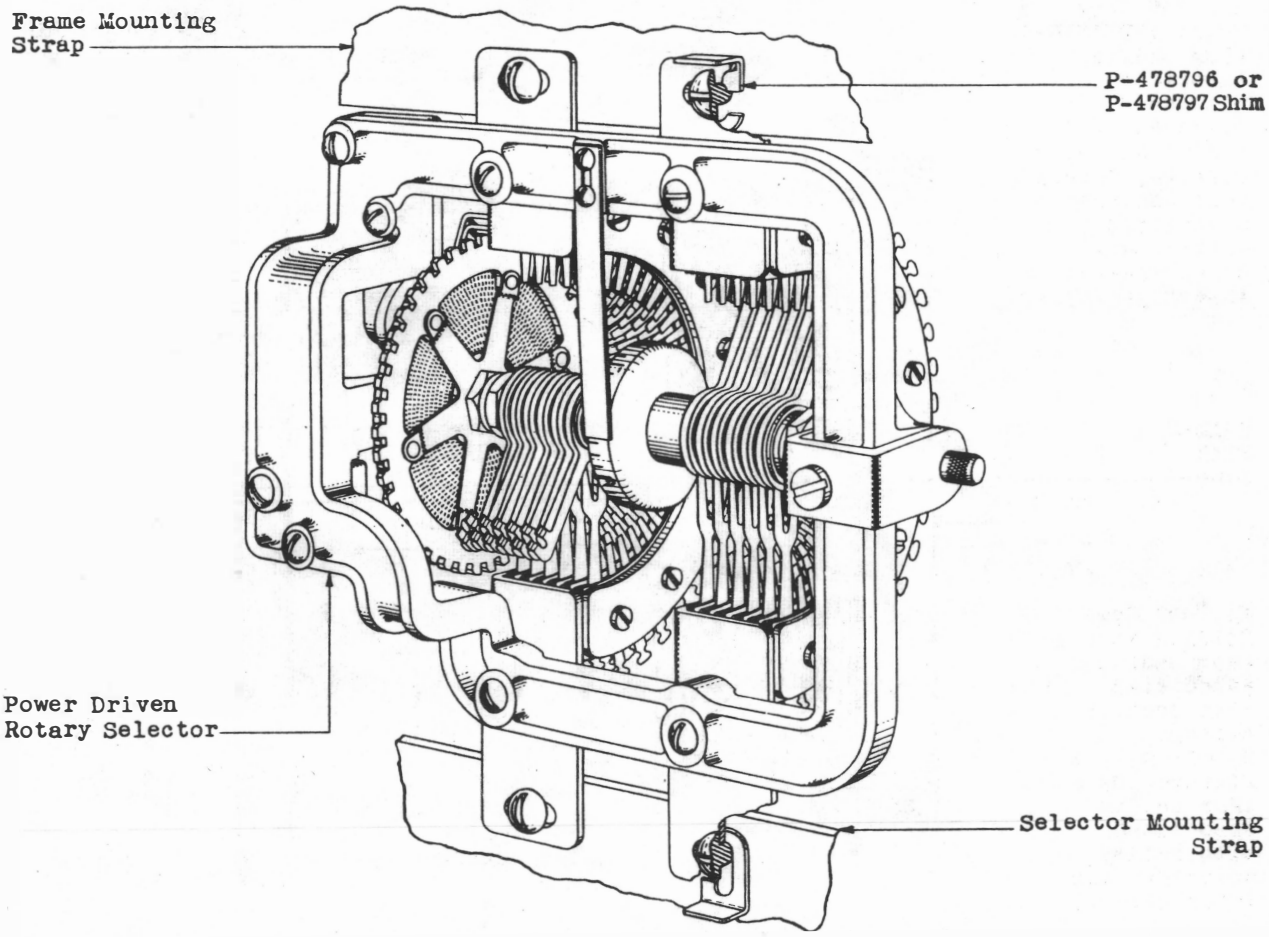

Fig. 7 - Method of Aligning Power Driven Rotary Selectors to Vertical Drive Shafts

Check the position of the discs immediately above and below each bearing over the entire length of the shaft in relation to the fish line in two positions, approximately 90° apart. The clearance between the periphery of these discs and the fish line shall not exceed 1/32". All discs must clear the fish line. To check a bearing where there is no driving disc adjacent to it or where there is a possibility that one or more driving discs are appreciably worn, attach the proper substitute disc to the shaft above the bearing as shown in Fig. 9. Check for a clearance between the fish line and the edges of the slot in the tool. This detail may be used at any other position on the shaft where there is a question of proper setting. Check first with the fish line in the extreme right-hand position and then revolve the shaft to the left through an angle of 90° and check again.

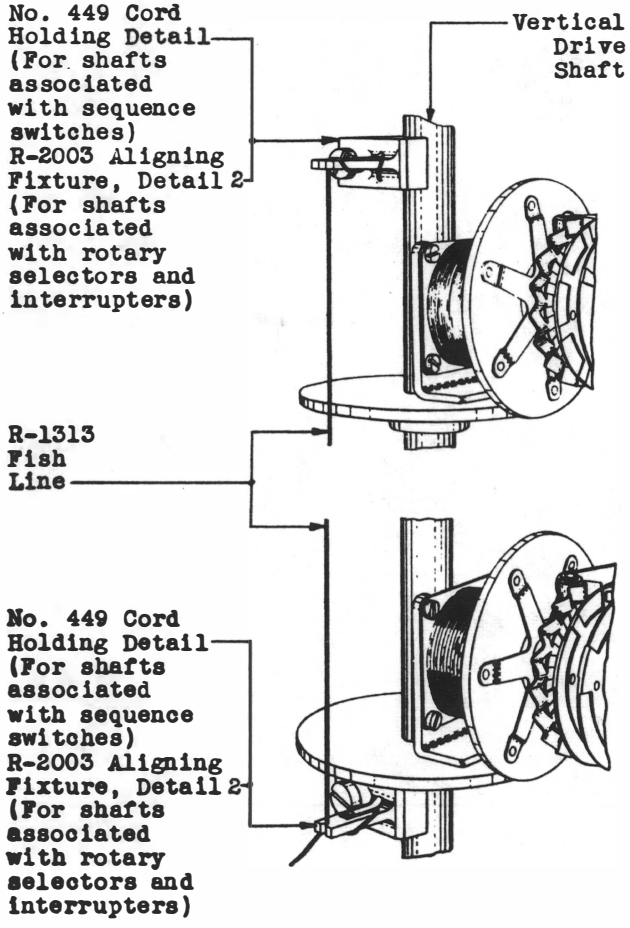
No. 449 Cord Holding Detail (For shafts associated with sequence switches) R-2003 Aligning Fixture, Detail 2 (For shafts associated with rotary selectors and interrupters)
Vertical Drive Shaft
R-1313 Fish Line
No. 449 Cord Holding Detail (For shafts associated with sequence switches) R-2003 Aligning Fixture, Detail 2 (For shafts associated with rotary selectors and interrupters)

Fig. 8 - Method of Checking for Location of Bearings

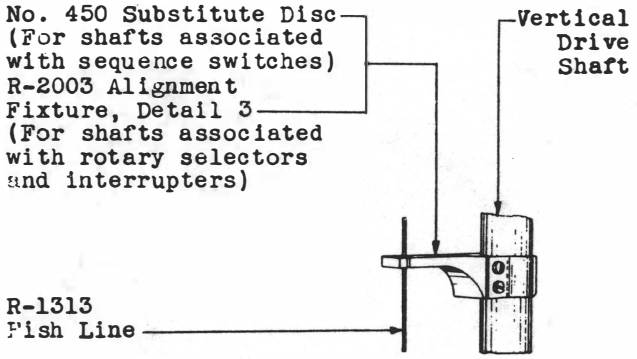
No. 450 Substitute Disc (For shafts associated with sequence switches) R-2003 Alignment Fixture, Detail 3 (For shafts associated with rotary selectors and interrupters)
Vertical Drive Shaft
R-1313 Fish Line

Fig. 9 - Method of Checking for Location of Bearings

2.08 Tightness of Bearing Cap Screws

(a) Fig. 10 (A)- Ball Bearings: The bearing cap screws shall be setup tight. Gauge by feel.

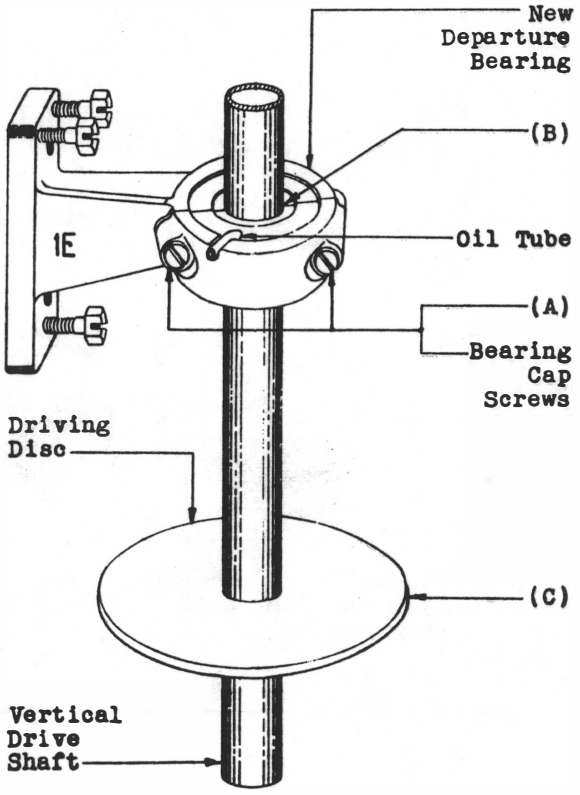

Fig. 10 - New Departure Bearing and Vertical Drive ft

(b) Fig. 11 (A)- Graphalloy Bearings Except No. 13A Bearings: The bearing cap screw nearer the frame channel shall be tightened so as to draw the bear-

ing cap tightly against the bearing bracket. The bearing cap screw further from the frame channel shall be tightened so as to hold the bushing snugly in position but not enough to distort the bushing. Gauge by feel.

(c) Fig. 12 (A) - No. 13A Bearings: The bearing cap shall be clamped tightly against the face of the bearing bracket so as to hold the bushing rigidly in position.

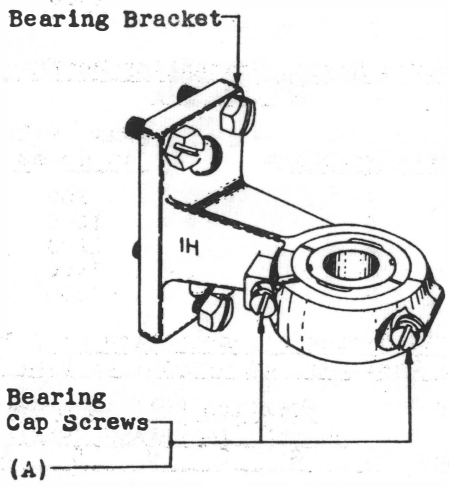

Fig. 11 - No. 1H Bearing

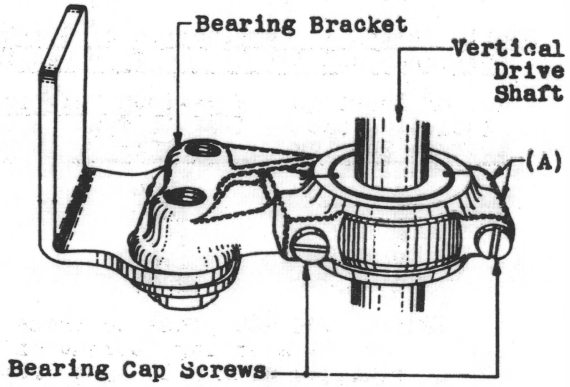

Fig. 12 - No. 13A Bearing

2.09 Radial Play in Bearings - Fig. 10 (B)

(a) The radial play in the bearings measured in a line parallel to the sequence switch cam shaft with the vertical shaft at rest and in two positions 90° apart shall not be more than:

Bearings	Time of Turnover Req.	Maintenance Req.
New Departure	.005"	.010"
Schatz	.012"	.020"
Graphalloy	.008"	.020"

Use the R-2040 dial indicator measuring gauge and the R-2039 indicator clamping fixture.

(b) When operating in its normal manner the vertical drive shaft shall not vibrate or chatter in the bearings when one of the two sequence switches located midway between any two intermediate graphalloy bearings is operated electrically and released. This requirement need not apply to shafts used to drive power driven rotary selectors.

2.10 Eccentricity of Vertical Drive Shaft and Driving Disc - Fig. 10 (C): The lateral movement of the vertical drive shaft during a complete revolution of the shaft, measured on the periphery of each driving disc shall not exceed

Test - .015"
Readjust - .012"

Use the R-2040 dial indicator gauge and the R-2039 indicator clamping fixture.

2.11 Squareness of Bearings

(a) Fig. 13 (A) - (New Departure): The lower finished surface of the bearing brackets associated with the New Departure bearings shall not be out of

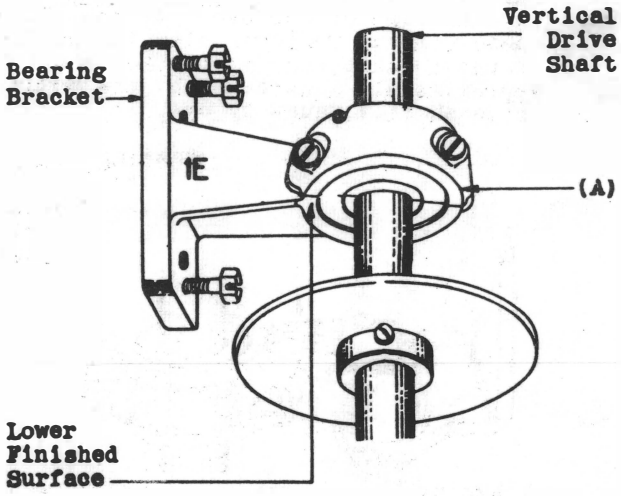

Fig. 13 - Relationship Between Bearing and Vertical Drive Shaft

perpendicular (out of square) with the axis of the vertical drive shaft more than:

Test .010"
Readjust - .008"

when measured across the outside diameter of the bearing bracket. Use the R-1306 bracket squaring gauge.

(b) (Schatz): These bearings shall meet the above readjust requirement unless it prevents the meeting of 2.12 in which case it shall be disregarded.

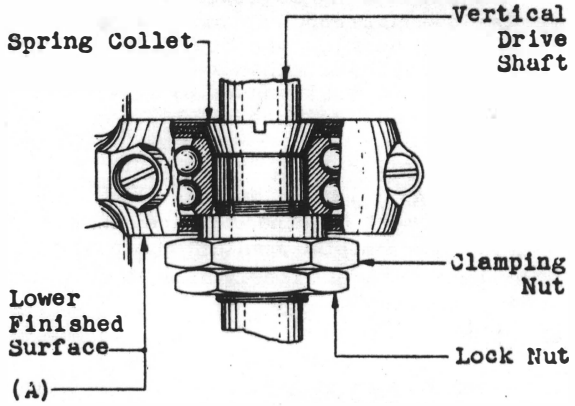

Fig. 14 - 10 Type Bearing

(c) Fig. 14 (A) - 10 Type and Graphalloy Bearings Except No. 13A Bearings: The lower finished surface of the bearing brackets shall be approximately square with the vertical drive shaft. Gauge by eye.

(d) Fig. 15 (A) - No. 13A Bearings: At the time of turnover to the Telephone Company the lower clamping surface of the die cast bearing bracket shall be approximately square with the vertical drive shaft. Gauge by eye.

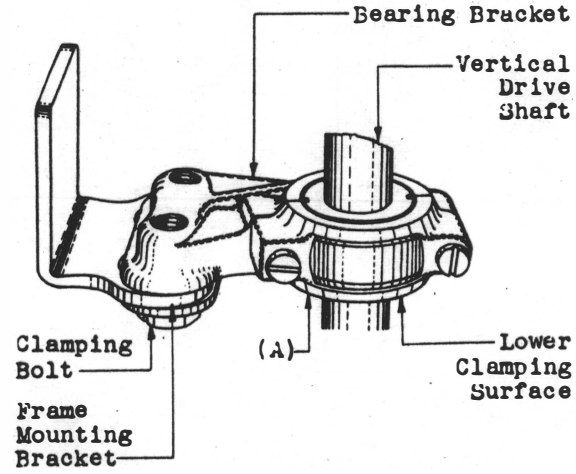

Fig. 15 - No. 13A Bearing

2.12 Starting Torque Test: The pull required to start the rotation of a shaft, from any position of rest about its axis, at the radius of the shaft shall be as follows. See Note (a).

Shafts Having 1 Type Ball Bearings Exclusively

No. of Shaft Bearings	#Max. Pull in Grams
4	700
5	800
6	900
7	1000
8	1100

Shafts Having Graphalloy Bearings Exclusively

No. of Shaft Bearings	#Max. Pull in Grams
4	800
5	1000
6	1200
7	1400
8	1600

Shafts Having a Combination of 1 Type Ball Bearings and Graphalloy Bearings

No. of Shaft Bearings	#Maximum Pull in Grams No. of Graphalloy Bearings 1	2	3	4	5	6	7
4	725	750	775				
5	850	875	925	950			
6	950	1000	1050	1100	1150		
7	1050	1125	1175	1225	1275	1350	
8	1150	1225	1275	1350	1425	1475	1525

Shafts Having a Combination of Graphalloy Bearings and One No. 10 Type Bearing

No. of Bearings Including One 10 Type Bearing	# Maximum Pull in Grams 1 or 11 Type Shafts	9 Type Shafts
4	1000	1100
5	1200	1300
6	1400	1500
7	1700	1800
8	2000	2100

#Note: Add 400 grams to these values for the starting torque of shafts equipped with a 16 type drive. The torque shall be measured on the lower or high speed shaft.

Use the No. 79E gauge.

Note (a): This requirement shall not apply as a test requirement to shafts driving reciprocating bar type interrupters only.

Before checking this requirement the gear guards shall be removed and any outside cause of friction such as the interrupter gears, the coupling and driving discs touching the driven discs, etc., eliminated.

This requirement may be checked for by the Telephone Company if they require it before the Installation Department has mounted the coupling between the vertical drive shaft and the vertical shaft of the drive.

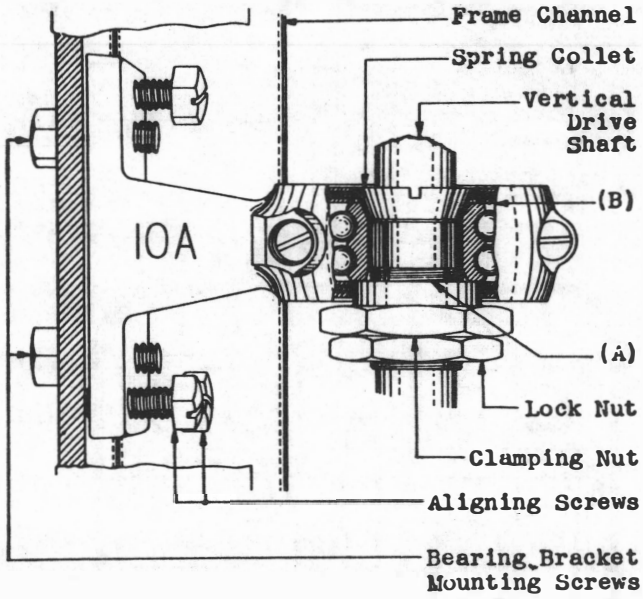

Fig. 16 - No. 10A Bearing

2.13 Position and Grip of Clamping Collar or Clamping Nuts (10 Type Bearings) - Fig. 16 (A): The clamping collar or clamping nuts shall be turned up tightly against the inner ball race and shall be securely clamped to the spring collet to prevent the bearing from slipping on the shaft. Gauge by feel.

2.14 Location of 10 Type Bearing In Its Housing - Fig. 16 (B): The ball bearings shall be so located in the bearing housing that the upward thrust on the shaft is taken by the bearing housing. Gauge by eye and feel.

This requirement shall be considered met if the play between the radial slot at the top of the housing and the associated felt and metal washers is taken up in an upward direction and the ball bearing rests against the lower metal washer at the top of the housing.

2.15 Location of Adapters and Graphalloy Bushing:

(a) Fig. 17 (A): The gaps between the adapters shall line up approximately (within 1/64") with the gaps between the cap and the bearing bracket, as viewed from the top of the bearing. Gauge by eye.

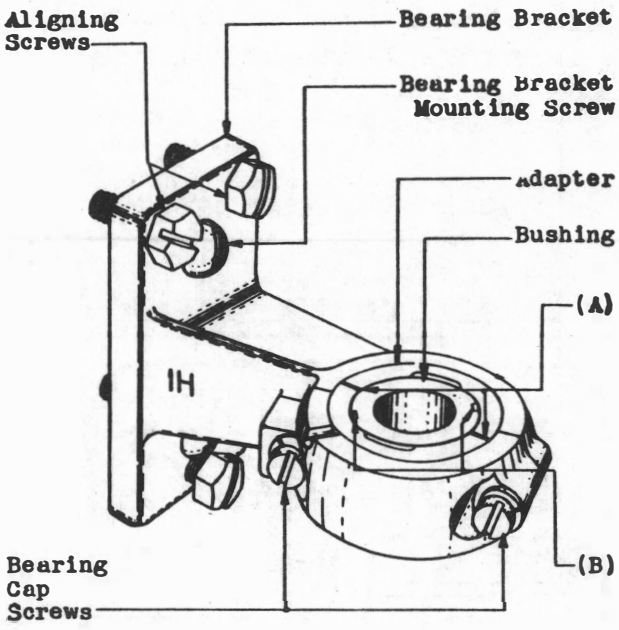

Fig. 17 - No. 1H Bearing

(b) Fig. 17 (B): The saw slots in the bushings shall be approximately 1/4" (within .010") in a counter-clockwise direction from the gaps between the adapters as viewed from the top of the bearing. Gauge by eye.

Requirements for Eccentric Couplings

*2.16 Axial Alignment of Shafts - Fig. 18(A): The distance from the centerline of the vertical drive shaft to the centerline of the vertical shaft of the drive in its worst position shall not exceed 3/32". Use the R-5320 gauge.

*2.17 Clearance Between Shafts - Fig. 18(B): There shall be a clearance between the bottom end of the vertical drive shaft and the top end of the vertical shaft of the drive of:
Min. 3/16"
Gauge by eye.

2.18 Engagement of Coupling - Fig. 19 (A)

(a) The eccentric coupling shall engage the vertical drive shaft by:
Min. 5/8"
Gauge by eye.

(b) This requirement shall be considered an asterisked (*) requirement when the eccentric coupling is enclosed by an eccentric coupling guard.

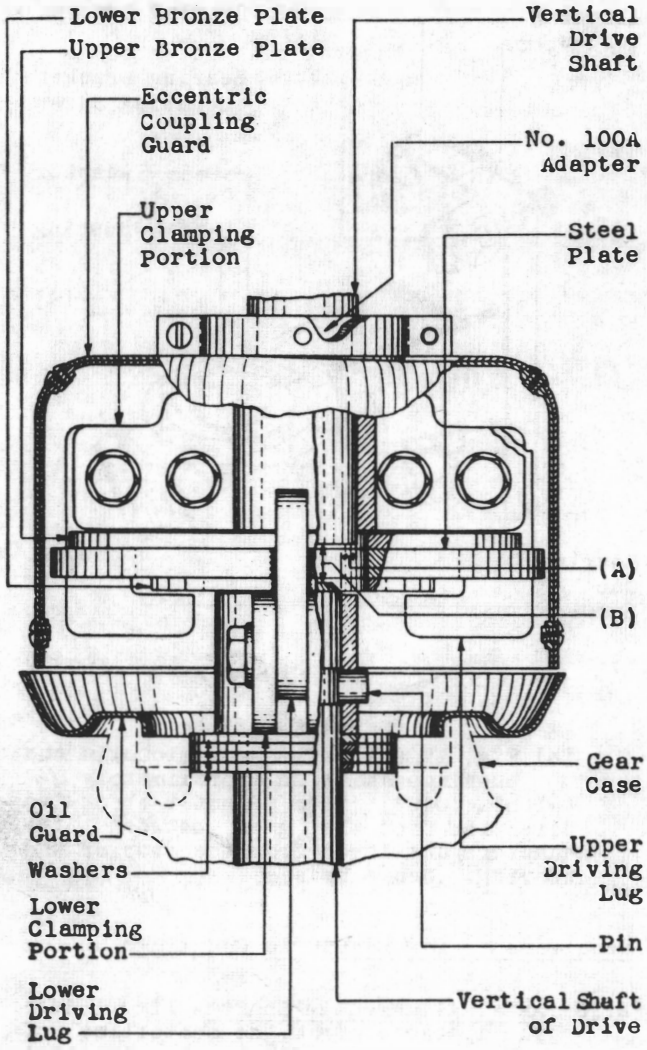

Fig. 18 - Eccentric Coupling and Eccentric Coupling Guard

2.19 Coupling Adjustment - Fig. 19 (B)

(a) There shall be some clearance between each driving and driven lug and its associated bronze plate throughout one complete revolution of the shaft but this clearance measured at each lug at a point nearest to the bronze plate shall be:
Max. .003"
Use the No. 74D gauge.

(b) This requirement shall be considered an asterisked (*) requirement when the eccentric coupling is enclosed by an eccentric coupling guard.

2.20 Mounting of Eccentric Coupling Guard

(a) Fig. 19 (C) - The vertical clearance between the bottom edge of the eccentric coupling guard and the upper edge of the oil guard shall be
Min. 3/64"
Max. 5/64"
Use the R-8550 steel scale.

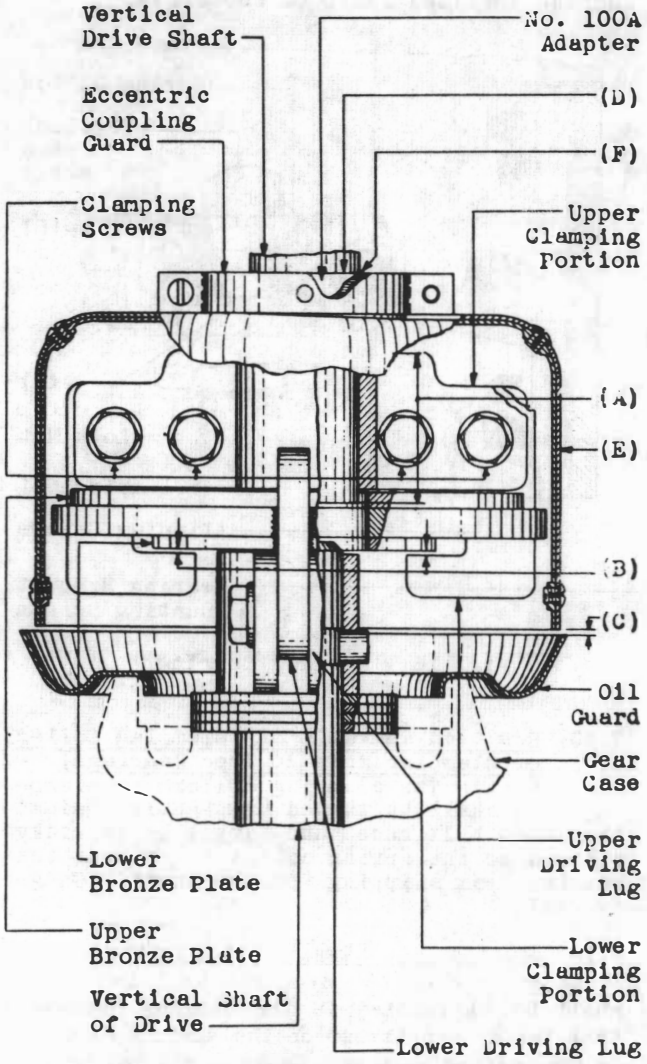

Fig. 19 - Eccentric Coupling and Eccentric Coupling Guard

(b) Fig. 19 (D) - The upper surface of the eccentric coupling guard collar shall be approximately flush with the upper surface of the associated No. 100A adapter unless the adapter mounts directly against the No. 5A drive hub in which case the coupling guard collar may extend up above the adapter. Gauge by eye.

(c) Fig. 20 (A) - When the eccentric coupling guard mounts on a No. 5A drive hub it shall overlap the straight sides of the hub by approximately one-half the height of the eccentric coupling guard

collar except in cases where the No. 100A adapter is mounted directly against it. Gauge by eye.

(d) The following points shall be sealed with KS-6824 sealing compound.

(1) Fig. 19 (E) - The joints where the eccentric coupling guard halves overlap.

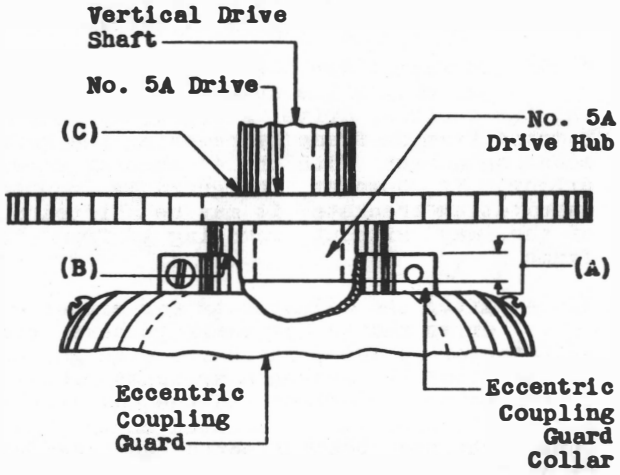

Fig. 20 - Relationship Between Eccentric Guard and No. 5A Drive

(2) Fig. 19 (F) - The joints between the eccentric coupling guard collar and the No. 100A adapter (where used) and the slots in the collar.

(3) The slots in the No. 100A adapter and the joint between the adapter and the shaft.

(4) Fig. 20 (B) - The joints between the eccentric coupling guard collar and the No. 5A drive (where used to mount the coupling guard) and the slot in the collar.

(5) Fig. 20 (C) - The joint between the No. 5A drive and the shaft.

Note: Eccentric coupling guards are not required on 33, 34, 45, 46, 47, 48 and 1034 type drives.

3. ADJUSTING PROCEDURES

3.001 List of Tools, Gauges and Materials

Code or Spec.No.	Description
Tools	
33	11/32" Hex. Single End Socket Wrench
206	30° Offset Screw-driver
207	90° Offset Screw-driver
232	1-3/8" Hex. Open Single End Offset Wrench
245	3/8" and 7/16" Hex. Open Double End Flat Wrench
247	1-1/4" Hex. Open Single End Flat Wrench
254	1/4" Square Single End Socket Wrench
322	Bearing Staking Tool
346	Spanner Wrench
347	Spanner Wrench
358	Cleaning Tool
427A	Shaft Supporting Tool
431A	Oil Gun
449A (2 required)	Cord Holding Detail
450A	Substitute Disc
R-2003 Details 2&3 (2 required)	Aligning Fixture
KS-14164	No. 4 Artist's Show Card Brush
R-1021	1/2" Brush
-	Bell System Standard Typewriter Brush (Toothbrush Type)
R-1051	6" Pillar File
R-2039	Indicator Clamping Fixture
R-80238	Shaft Straightening Fixture
-	Goggles, Impact
R-1060	Putty Knife
R-1313	Fish Line
-	6-1/2" P-Long Nose Pliers
- (2 required)	4" Regular Screw-driver
-	3" Cabinet Screw-driver
R-1994	Wedge
KS-6098	5/32" Bristo Set Screw Wrench
KS-6263	9/32" Straight Hex. Socket Wrench
KS-8097	5/8" and 7/16" 12 Point Offset Box Wrench
R-1770	1/2" and 9/16" Hex. Flat Open Double End Wrench

Code or Spec. No.	Description
Gauges	
74D	Thickness Gauge Nest
79E	0-3000 Gram Push-Pull Tension Gauge
85	Thickness Gauge (Size as required)
120A	Shaft Locating Fixture
159A	Shaft Locating Fixture
R-1306	Bracket Squaring Gauge
R-2040	Dial Indicator Gauge
R-5320	Vertical Drive Shaft Alignment Gauge
R-8550	Steel Scale
Materials	
-	Aluminum Paint
-	Carborundum Paper - No. 00
-	Chalk
D-98063	Cloth
KS-8372	Trichloroethylene
KS-7860	Petroleum Spirits
-	Hardwood, Flat Piece, (for stirring sealing compound)
-	Petrolatum per Spec. No. 57997
KS-2245	Oil
KS-6438	Oil
KS-6824	Sealing Compound
P-290306	Shim (.028") (Used on Sequence Switches)
P-290307	Shim (.056") (Used on Sequence Switches)
P-478797	Shim (.028") (Used on Power Driven Rotary Selectors)
P-478796	Shim (.056") (Used on Power Driven Rotary Selectors)
P-426775	Screw (1/2" x .164" x 30) (Used on Sequence Switches)
P-426776	Screw (3/4" x .164" x 30) (Used on Sequence Switches and Power Driven Rotary Selectors)
P-126419	Washers
-	Wood, Flat Piece, 1/8" Thick

3.002 Before stopping a drive to make any of the inspections or readjustments specified herein, ascertain whether it is necessary to make any of the associated circuits busy. Make circuits so affected busy in the approved manner. If two corresponding sides of adjacent frames are run by the same motor and it is necessary to remove the shaft from one frame or to have the shaft at rest for an extended period so that adjustments may be made, the vertical shaft may be uncoupled and the frame not affected by the adjustment restored to service.

3.003 To facilitate the inspection and adjustment of the apparatus given herein, the vertical drive shaft guard may be removed from the frame by removing the guard mounting screws with the 4" regular screwdriver. If, however, the guard is mounted on rotating brackets it may be shifted out of the way without removing it from the frame.

3.004 After the adjustments for either the drive shafts or bearings have been satisfactorily made, check the disc gap adjustments of the sequence switches and power driven rotary selectors and the adjustments for interrupter gears mounted on the frame that might have been affected and readjust as outlined in the procedures for this apparatus.

3.005 When removing the KS-6824 sealing compound from the eccentric coupling guard and No. 100A adapter, it is advisable to use the goggles to prevent flying particles of the compound getting in the eyes.

3.01 Cleaning (Rq.2.01)

(1) To wipe off the bearing housing, the shaft above and below the bearings and the driving and driven discs proceed as follows: Wrap aD-98063 cloth tightly around the No. 358 tool in a spiral manner so that one end of the tool is completely covered and the loose end of the cloth is held with the hand or tied with string. Then moisten the cloth with KS-7860 petroleum spirits. Exercise care that the cloth does not become caught in the moving parts or that the tool and cloth does not become wedged between the apparatus.

(2) If an eccentric coupling is dirty or gummy due to the improper use of KS-6438 oil, remove the eccentric coupling as outlined in 3.16 to 3.19 inclusive and thoroughly clean the parts with KS-7860 petroleum spirits and then lubricate the parts as outlined in 3.02.

3.02 Lubrication (Rq.2.02)

Ball Bearings

(1) Lubricate bearings having washers equipped with an oil hole by means of the No. 431A oil gun equipped with

a curved nozzle and bearings equipped with an oil tube, such as the No. 1F bearings, by means of the No. 431A oil gun equipped with a straight nozzle. In both the above cases, perform the oiling operation wherever possible without stopping the shaft or loosening the bearing cap. Fill the oil gun as covered in the section covering lubricators, oil, and grease guns.

(2) Insert the tip of the nozzle of the oil gun in the oil hole or oil tube and press very slowly on the plunger until it is depressed to the limit of its stroke. Wherever possible, discharge the oil gun at such a rate that the shaft makes at least two complete revolutions before the plunger is entirely depressed. If the operation is performed correctly, there will be no oil leakage.

(3) When lubricating No. 1E and No. 1F bearings, exercise care to insert the straight nozzle in the oil tube as far as possible in line with the center line of the horizontal portion of the oil tube. This is necessary in order to prevent the oil from leaking out of the oil tube as the plunger is depressed.

(4) To lubricate bearings which are not equipped with an oil tube or having washers which are not equipped with an oil hole, it will be necessary to stop the associated drive shaft and remove the bearing cap, the two outer split metal washers, and the two outer felt washers. Distribute the lubricant over the balls which are exposed with a No. 431A oil gun. Replace the parts removed after lubricating the bearing and restore the frame to service.

(5) Wipe off any lubricant that may have leaked through the bearing on the shaft below or which may have been spilled in lubricating the bearing with D-98063 cloth moistened with KS-7860 petroleum spirits.

(6) In all cases, however, make an inspection after the shaft has been operated 24 hours since the application of the lubricant and remove any lubricant that has leaked out as covered above. If an indication of rust is noted, flush the bearing with KS-6438 oil by applying an extra charge of oil in the bearing, taking the necessary precautions to catch the excess lubricant which will be forced from the bearing.

(7) With the coupling disassembled, apply a film of KS-6438 oil to the area of the coupling plates which contact each other. The surfaces should be completely covered with a uniform film of oil.

(8) With the coupling assembled, apply two discharges of the oil from the No. 431A oil gun as follows. With the shaft rotating, place the tip of the nozzle on the steel plate, resting it against the outside edge of the bronze plate. If one edge of the bronze plate is nearer the shaft than the other, rest the nozzle against the edge of the plate. Then, as the shaft revolves, depress the plunger slowly so that the shaft makes at least one revolution before the plunger is entirely depressed. Then release the plunger and repeat the operation. After placing two discharges on the plate, place one discharge on the shaft at the top surface of the upper clamping portion of the coupling.

3.03 ***Record of Lubrication*** (Reqt 2.03)
(no procedure)

3.04 ***Grip of Schatz Bearing Sleeve***
(Reqt 2.04)

(1) To check whether or not the inner sleeve of the Schatz bearing slips on the shaft, stop the shaft and grasp the sleeve of the bearing with the thumb and forefinger and attempt to turn it.

(2) To stake a sleeve, proceed as follows. Apply a thin film of petrolatum over the tips of the No. 322 bearing staking tool and, working from the front of the frame, place the tool directly beneath the bearing between the vertical shaft and the frame channel. Hold it firmly against the bearing bracket and sleeve in such a manner that each of the two points of the tool is brought to bear on the sleeve approximately midway between slots.

(3) With the tool held in this position, grasp the handle as shown in Fig. 21 and turn it from three to five complete turns according to the looseness of the bearing.

(4) Repeat this operation with the shaft moved approximately 90 degrees so that the sleeve is staked to the shaft at four points.

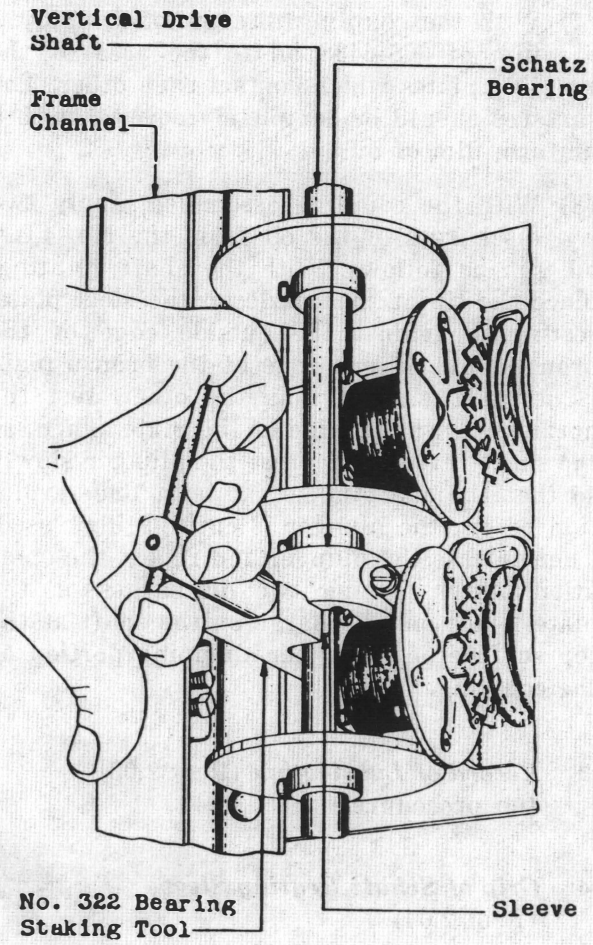

Fig. 21 – Method of Staking Schatz Bearing

(5) Remove any burrs on the split sleeve caused by the staking operation with the R-1051 file.

(6) Recheck for looseness of the sleeve and, if satisfactory, check the "Starting Torque" as outlined in 3.12 to determine that a bind has not been introduced into the bearing by the staking operation.

3.05 ***Mounting of Bearing Brackets*** (Rq. 2.05)

(1) To determine whether or not the bearings are rigidly fastened to the frame (or in the case of the No. 13A bearings to the frame mounting bracket), attempt to tighten the bracket mounting screws (or bracket clamping bolts) with the No. 245, KS-8097, or R-1770 wrench. In the case of No. 1B, 1F, and 1H bearing, use the 4″ regular screwdriver. If the screws move with comparative ease, securely tighten them and check 2.06, 2.07, 2.11 and 2.12 and make any necessary readjustments.

3.06 ***Location of Shafts and Bearings*** (Rq. 2.06)

3.07 ***Alignment of Vertical Drive Shaft Bearings*** (Rq. 2.07)

(1) The more closely bearings are spaced, the more important it is to put the bearings in correct alignment. A small amount of misalignment under such conditions will produce a bind.

(2) Paragraphs (3) to (10) inclusive cover the procedures for aligning vertical drive shafts associated with sequence switches and paragraphs (11) to (16) inclusive cover the procedures for aligning vertical drive shafts associated with power driven rotary selectors. Where other apparatus is mounted in the frame, the W.E.Co.'s R-2447 gauge should be used in aligning the shaft.

Sequence Switches Where Shafts Are Too Far Forward

(3) If the shaft is too far forward, opposite a number of sequence switches, give consideration to realigning the shaft as outlined in (8) to (10) and (17) to (20) inclusive for shafts that are too far back. If the number of sequence switches is not appreciable, insert as many P-290306 and P-290307 shims as required between the sequence switch mounting strap and the sequence switch frame to bring the sequence switch into alignment. It is not always necessary to insert the same number of shims under each screw. In some cases, the sequence switch may be satisfactorily positioned by inserting a shim or shims under the screw or screws at one end of the switch only. When inserting shims under the screws at the vertical drive shaft end of the sequence switch, do not tilt the switch enough to destroy the relation between the magnet heelpiece and the driving disc which should be approximately parallel. To this end, it is generally necessary to insert the same number and size shims under both screws. Where the sequence switch mounting screws are used to mount contact protection on the wiring side to the frame and more than one P-290307 shim

is to be used under a screw, replace the existing screw with a P-426776 screw and proceed as covered in (5). Where the mounting screws do not secure this apparatus to the frame and more than one P-290307 shim is to be used under a screw, replace the existing screw with a P-426775 screw and proceed as covered in (4). It is advisable, when mounting more than one shim over each mounting screw, to mount the shims individually in order to reduce the possibility of dropping the shims.

(4) Loosen the sequence switch mounting screws with the 4-inch regular screwdriver. Grasp the tab of the shim with the long-nose pliers and slide the shim along between the mounting strap and the sequence switch frame from right to left and hook the shim over the mounting screw. Take care not to allow the pliers to come in contact with the sequence switch cams or springs. Make sure that each shim rests on its mounting screw. This may be determined by applying a pressure to the tab in a downward direction. Where one shim is used, position it so that the long leg of the shim assumes a vertical position but, where more than one shim is used, the long straight leg of each shim should be at a slight angle to the vertical so as to separate the tabs of the shims. Take care in mounting the shims under the upper left hand mounting screw not to al-

low the shims to rest on the frame of the "A" cam roller assembly. After the shims are mounted, adjust the sequence switch to meet the requirement covering clearance between the mounting screws and the right-hand end of the slots in the sequence switch frame and the requirements covering the driven disc gaps. Then tighten the mounting screws securely while holding the switch in this position.

(5) Where contact protection units are mounted on the wiring side of the frame by means of sequence switch mounting screws of two adjacent sequence switches, it will be necessary to remove the contact protection mounting nut in order to remove the sequence switch mounting screw associated with the sequence switch being adjusted. Where the contact protection mounting nut is accessible, remove it with the No. 33 wrench, or, in case there is insufficient clearance to permit the use of the wrench, remove it with the long nose pliers. Where the condenser is mounted with its long axis perpendicular to the sequence switch mounting strap, it will be necessary to remove the condenser from the bracket in order to gain access to the nut mounted on the upper sequence switch mounting screw of the lower sequence switch. To do this, hold the condenser bracket clamping nut with the long nose pliers or the fingers and remove the clamping screw with the Nos. 206 and 207 screw-drivers. Move the condenser from the bracket sidewise far enough to permit the removal of the mounting nut with the No. 33 wrench. Where a terminal of the condenser is wired to a terminal punching which is mounted under the contact protection mounting nut, remove the punching from the mounting screw. Take care when moving the condenser, terminal punchings or condenser terminals not to damage or short circuit the wiring. After removing the mounting nut, proceed as outlined in (4) to position the sequence switch.

(6) After the sequence switch has been satisfactorily positioned, remount the terminal punching, if removed, on its associated sequence switch mounting screw. Remount and securely tighten the contact protection mounting nuts. Remount the condenser on its mounting bracket if removed, and insert the clamping screw through the bracket. Mount and tighten the condenser bracket mounting nut on the clamping screw with the Nos. 206 and 207 screw-drivers. Take care when tightening the screw to tighten it only enough to hold the condenser firmly in position since damage to the condenser case will occur if the screw is made excessively tight.

(7) Recheck the location of the shaft as outlined in 2.06

Where Shafts are Too Far Back and Where Necessary to Realign Shaft

(8) Before realigning a shaft note the direction of misalignment and the clearance between the sequence switch mounting screws and the right hand end of the slots in the sequence switch frame throughout the length of the frame. Where the misalignment is slight, the condition may be corrected by inserting shims as outlined in (3) over the mounting screws at the right hand end of the sequence switch or over the mounting screw at the top of the sequence switch. Where front to rear misalignment cannot be corrected in this manner and where the misalignment is in one direction proceed as outlined in (9) where it is not in one direction proceed as outlined in (10). When relocating the bearings for front to rear location of the shafts also adjust the right to left position of the bearings if necessary to obtain satisfactory clearances of the sequence switch mounting screws.

(9) Note whether that portion of the shaft which is satisfactorily aligned, leans in the same direction as that portion of the shaft which is not within limits. In this case, determine the best average adjustment within limits and readjust the shaft to this average position as follows. Place the No. 120A gauge against the sequence switch adjacent to the bearing bracket to be realigned and note the position of the shaft with regard to the average position. On all bearings requiring adjustment, loosen the bracket mounting screws or bracket clamping bolts. To do this, loosen the screws or bolts of Nos. 1A, 1E, 1G, 10A and 13A bearings with the No. 245, KS-8097 or R-1770 wrench or on No. 1B, 1F, 1H and 10B bearings with the 4" regular screw-driver. Adjust the aligning screws of the 1 and 10 type bearings, as required with the No. 245 or KS-8097 wrench or shift the bearing bracket of the No. 13A bearing back and forth or in and out as required. Hold the bracket in this position and tighten the mounting screws or clamping bolts enough to hold the bracket in place and recheck the position of the shaft with the gauge. After the bracket is satisfactorily aligned, tighten the mounting screws securely. Realign all other bearing brackets on the shaft in the same manner. If the right to left location of the lower end of the shaft as indicated by the clearance between the sequence switch mounting screws and the right hand end of the slot in the sequence switch frame is not satisfactory it may be necessary to remove the eccentric coupling as outlined in (10) before realigning the lowest bearing to insure meeting 2.15.

(10) If the misalignment is not in one direction or the clearances between the sequence switch or selector mounting screws and the slots are generally unsatisfactory, realign the entire shaft. To do this, remove the eccentric coupling as outlined in 3.15 and note the relationship between the vertical drive shaft and the vertical shaft of the drive. If it is not satisfactory readjust as outlined in 3.16 to 3.19 inclusive. Loosen the bracket mounting screws or bracket clamping bolts of the lowest bearing as outlined in (9). Align this bearing shifting it so that the vertical drive shaft is toward the right of the vertical shaft of the drive. Align the top bearing, if necessary, as outlined in (9).

Power Driven Rotary Selectors

(11) General: Due to the several methods of mounting and securing the power driven rotary selectors to the frame mounting straps, the procedures to be followed in aligning the selectors and the vertical drive shafts differ with the different mounting arrangements. Selectors may be mounted either in front or in back of the frame mounting straps. If they are mounted in back of the straps they may be mounted on studs and held in place by the mounting screws and nuts.

Where the Shafts are Too Far Forward

(12) If the shaft is too far forward opposite a number of power driven rotary selectors, give consideration to realigning the shaft as outlined in (8) to (10) and (17) to (20), inclusive. If the number of selectors is not appreciable, insert as many P-478796 and P-478797 shims as required between the selector mounting straps and the frame mounting straps or between the selector mounting straps and the studs, dependent upon the mounting arrangement. Where several shims are used on selectors mounted in front of the frame mounting straps, it may be desirable to use longer screws in order to securely mount the selectors. If this is necessary, replace the existing screws by the P-426776 screws. It is advisable when mounting more than one shim over a mounting screw to mount the shim individually to reduce the possibility of dropping the shims.

(13) Where Power Driven Rotary Selector is Mounted in Front of Frame Mounting Strap: Loosen the selector mounting screws on the top and bottom selector mounting straps at the left side of the selector with the 4" regular screwdriver and slightly loosen the mounting screws on the right side of the selector. To insert shims around the mounting screw at the upper left, grasp the tab of a shim with the fingers and with the tab uppermost, slide the shim along the upper frame mounting strap from left to right and hook it over the mounting screw. Make sure that each shim rests on its mounting screw. This may be determined by applying a pressure to the tab in a downward direction. To insert a shim around the mounting screw at the lower left, hold the shim with the tab down and slide it along the lower frame mounting strap from right to left and hook it over the mounting screw as before. Tighten the selector mounting screws in place and recheck the alignment of the selector as outlined in 2.06 and if it is satisfactorily aligned, adjust the position of the selector as required to meet the requirements covered in the section covering this apparatus.

Note: When inserting shims and making subsequent adjustments on 202 type selectors make sure that there is an adequate clearance between the vertical drive shaft and the selector magnet terminals when all the play in the shaft is taken up toward the magnet terminals. This may be checked for while the shaft is rotating by applying a slight pressure to the shaft opposite the magnet terminals. If the shaft touches the terminals more clearance may be obtained by replacing the magnet by a new one as outlined in the section covering power driven rotary selectors.

If necessary to realign the selector, loosen the mounting screws. After the selector has been satisfactorily aligned, tighten the mounting screws securely.

(14) Where the Power Driven Rotary Selector is Mounted in Back of the Mounting Strap: Hold the mounting nuts with the fingers and loosen the selector mounting screws on the top and bottom selector mounting straps at the right side of the selector with the 4" regular screwdriver and loosen the screws at the left side. To insert the shims around the mounting screw, grasp the tab of the shim as outlined in (13) for inserting the shims around the upper screw and while pressing on the head of the screw with the screwdriver so as to provide mounting space for the shim, insert the shim around the screw sliding it from left to right in back of the frame mounting strap and in front of the stud. To insert a shim around the mounting screw at the lower right, hold the shim with the tab down and slide it from right to left in back of the frame mounting strap and in front of the stud. Then proceed as outlined in (13) to check the alignment of the selector.

Where the Shafts are Too Far Back

(15) If the shaft is too far back opposite a number of power driven rotary selectors, give consideration to realigning the shaft as outlined in (8) to (10) and (17) to (20) inclusive. If the number of selectors is not appreciable proceed as outlined in (12) to (14) inclusive, except that the shims should be inserted around the mounting screws at the right side of the selector when the selector is mounted in front of the frame mounting strap and around the mounting screws at the left side of the selector when the selector is mounted behind the frame mounting straps.

(16) If the misalignment is not in one direction or if the clearances between the power driven rotary selector mounting screws and the slots are generally unsatisfactory, realign the entire shaft as outlined in (17) to (20), inclusive.

All Apparatus

(17) Before realigning the vertical drive shaft note whether any of the driving discs are worn and if they are give consideration to replacing them at this time. When the discs are satisfactory attach the cord holding details and check the position of the discs as outlined in 2.07. If the clearance exceeds 1/32" or if the fish line touches the driving disc of the top sequence switch or selector position, it is an indication that the bearing or bearings located above the top sequence switch or selector position are not in satisfactory adjustment and should be realigned. If necessary rotate the shaft to a position in which these discs clear the line and at the same time relocate the cord holding details.

(18) If the clearance between the fish line and the discs is not satisfactory, adjust the positions of the bearing brackets as follows.

(19) Loosen the mounting screws of all bearings mounted above with the No. 245, KS-8097 or R-1770 wrench. In case the top sequence switch or selector is not located at or near the top of the frame, do not loosen the mounting screws of any bearing mounted above it, but proceed directly to adjust the bearing as follows:

(20) Loosen the mounting screws of the intermediate bearings as outlined in (10) and turn the aligning screws with the No. 245 or KS-8097 wrench or shift the bearing bracket as required until the driving disc just clears the fish line and a satisfactory clearance exists between the sequence switch or selector mounting screws and the right hand end of the slots in the sequence switch or selector frame. Before tightening the mounting screws, check the position of the bearings for squareness. After the bearings are satisfactorily aligned, tighten the mounting screws securely, and recheck as outlined in 2.06. If the eccentric coupling has not been removed, remove it at this time as outlined in 3.16 to 3.19 inclusive and check that the shaft is meeting the torque requirement. If it is not meeting the requirement it will be necessary to realign the shaft taking care that the torque requirement as well as the shaft alignment and axial alignment requirements are met and that a satisfactory clearance exists between the sequence switch or selector mounting screws and the right hand end of the slots in the sequence switch or selector frames. After the shaft is satisfactorily located, reassemble the eccentric coupling as outlined in 3.16 to 3.19 inclusive.

3.08 Tightness of Bearing Cap Screws (Rq.2.08)

(1) Securely tighten the bearing cap screws of all ball bearings with the 4" regular screwdriver. In the case of bearings having graphalloy bushings, tighten the screw further from the frame channel just enough to hold the bushing snugly in position but not enough to distort the bushing. This may or may not cause the cap to seat against the bracket.

3.09 Radial Play in Bearings (Rq.2.09)

(1) To check a bearing for radial play, attach the R-2040 dial indicator measuring gauge to the channel by means of R-2039 indicator clamping fixture as shown in Fig. 22. Place the indicator as near as possible to the bearing to be checked and in a position in which it will indicate any movement of the shaft toward or away from the sequence switches.

(2) Move the shaft toward and away from the sequence switches or other associated apparatus the full distance the shaft can be moved by applying a reasonable pressure with the fingers, at a point near to the bearing being checked, and note the change in the indicator reading. Take care not to spring the shaft in making this check. Levers of any sort must not be used for applying the pressure.

(3) Rotate the shaft 90" and repeat this test.

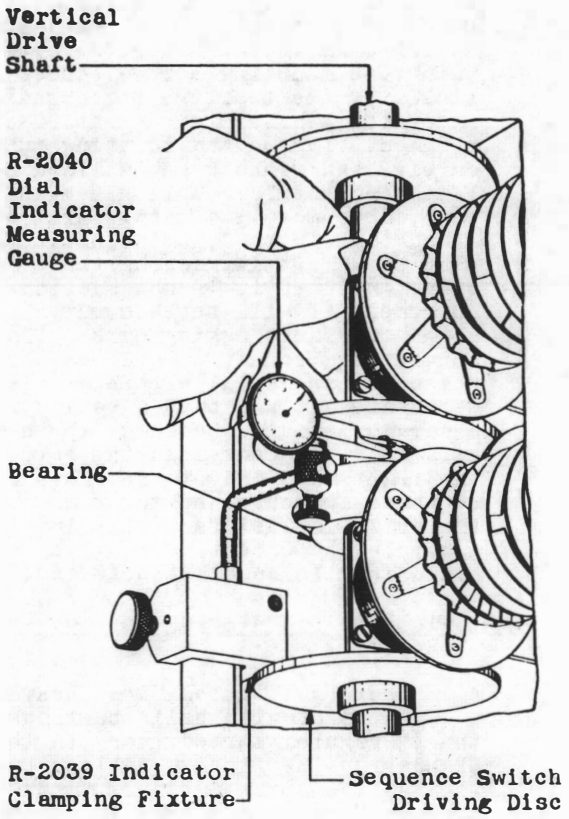

Fig. 22 - Method of Gauging Radial Play

(4) The interrupter gears may interfere with the check for radial play of bearings associated with interrupters. If in checking these bearings, this condition is found to exist, lower the vertical drive shaft gears to clear the gears meshing with them. It is not necessary to move any sequence switches or interrupter assemblies to check for radial play.

(5) All bearings that exceed the specified amount of radial play should be replaced as outlined in the section covering this apparatus.

(6) If a shaft equipped with graphalloy bearings is observed to chatter or vibrate the condition may be remedied by readjusting the position of the bearing near the center of the vibrating portion. In some cases, it may be necessary to slightly misalign a bearing in order to eliminate the chatter of vibration.

3.10 Eccentricity of Vertical Drive Shaft and Driving Disc (Rq.2.10)

(1) To check for eccentricity of the vertical drive shaft, mount the R-2039 indicator clamping fixture on the frame and attach the R-2040 dial indicator measuring gauge so that the ball tip of the gauge is approximately centered at a point on the periphery of the disc as near as possible to the point of contact of the disc as shown in Fig. 23. Adjust the indicator needle of the gauge by moving the gauge toward or away from the driving disc to assume a position about one half of a revolution from its starting point, so that the ball tip may follow the total movement of the disc as it is rotated.

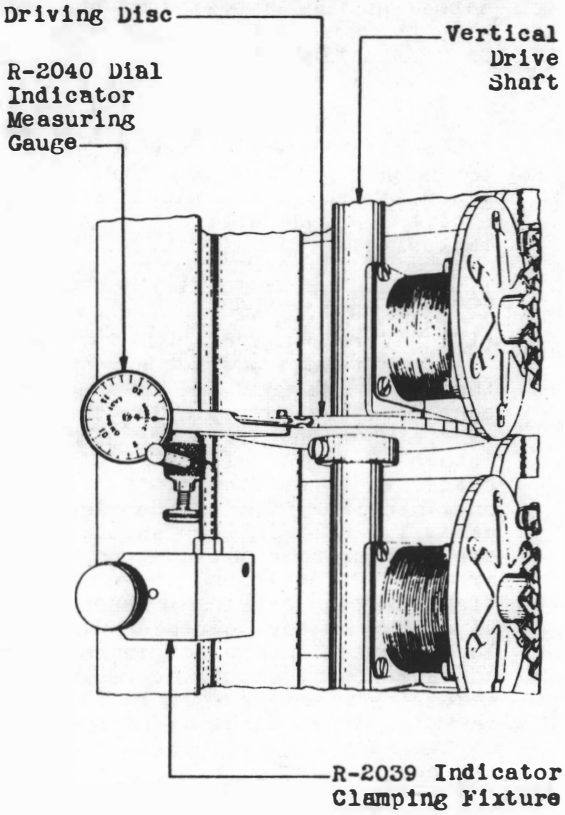

Fig. 23 - Method of Gauging Eccentricity of Vertical Drive Shaft

(2) Rotate the shaft by hand or under power, preferably by hand, through at least one complete revolution and note the minimum and the maximum readings of the indicator gauge. If the difference in these two readings exceeds .015" readjust as follows:

(3) Slightly loosen the driving disc clamping screw with the 4" regular screwdriver or the KS-6098 Bristo set screw wrench as required and turn the disc on the shaft through an arc of about 60 degrees. With the disc in this position

check to see that the total lateral movement of the disc does not exceed .012" measured as outlined above. If the requirement is not met with the disc in this position continue to rotate the disc 60° at a time, throughout 360° if necessary, until a satisfactory position is found.

(4) If it is impossible to meet the requirement after readjusting the apparatus as outlined above, the shaft is probably slightly bowed. To correct for this proceed as follows.

(5) Straightening a Shaft Without Removing it from the Frame: Where there is a bow in a shaft which prevents the apparatus from meeting the eccentricity requirement apply the R-80238 shaft straightening tool. It is also sometimes necessary to make this adjustment after a tilted bearing has been corrected. In no case shall it be used over a bearing which is rigidly mounted.

(6) Determine the character and the length of the bow or bows in a shaft by revolving it and observing the gap between the driving and driven discs. This may be done by holding a piece of chalk near the periphery of the disc which is located midway between the two top bearings associated with the sequence switches and revolving the shaft and allowing the chalk to touch the disc at the high spot.

(7) Place the R-80238 shaft straightening tool in position so that the end supports of the tool rest against the shaft at approximately the points where the bow begins and the bending portion on the tool bears against the shaft at the point of maximum bow as shown in Fig. 24.

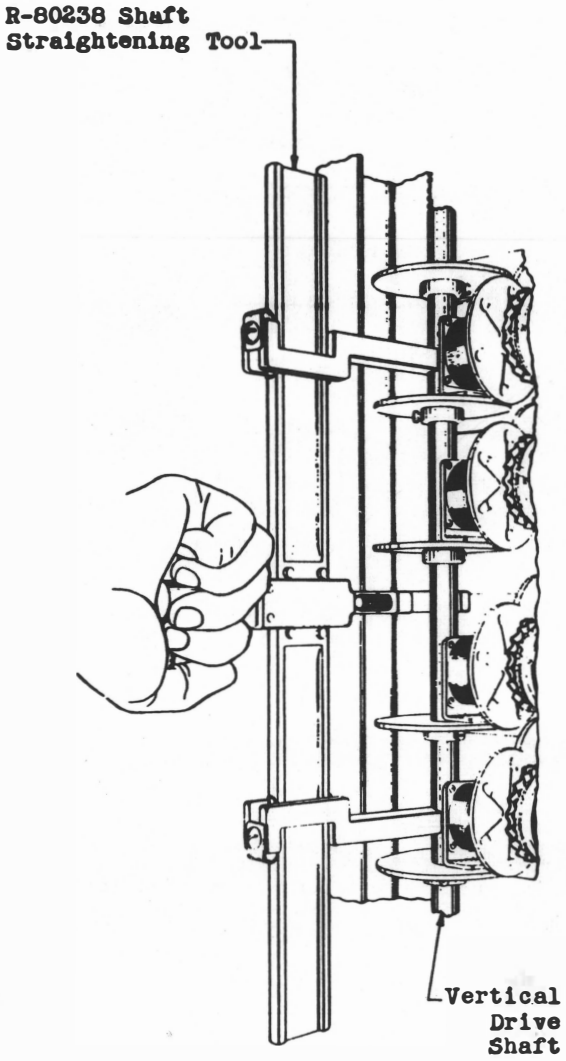

Fig. 24 - Method of Straightening a Vertical Drive Shaft

Caution: The R-80238 shaft straightening tool was not designed for use on solid shafts (9 type shafts). Consideration should be given to replacing any solid shaft (9 type shaft) requiring straightening. When used on tubular shafts (1 type shafts) the support arms should be at least 2" from the adjusting screw.

(8) Bend the shaft so as to remove the bow. Recheck the discs in the manner previously described and repeat the operation until the eccentricity is within the specified limit. Care must be used to prevent any strain on the bearings when using the straightening tool. The tool shall not be used over a bearing which is fastened to the frame as this would cause an excessive strain on the ball unit. When it is necessary to straighten a shaft at a bearing, the bearing bracket shall be removed from the channel and moved up or down out of the way. After using the straightening tool, remove the coupling and check for starting torque and make any readjustments necessary to meet the torque requirements as outlined in 3.12.

(9) If necessary repeat the bending operation beginning at the central disc between each two bearings in order from top to bottom.

(10) If difficulty is encountered or the shaft is badly bowed it will be economical to replace it with a new shaft instead of attempting to straighten it.

3.11 Squareness of Bearings (Rq.2.11)

(1) 1 Type Ball Bearings: To check a bearing for squareness hold the R-1306 bracket squaring gauge with the "V" surface against the shaft and the undersurface of the bearing bracket as shown in Fig. 25.

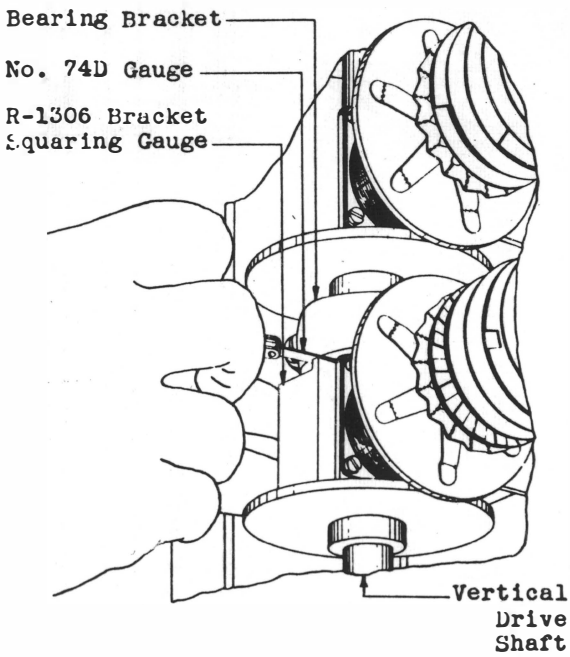

Fig. 25 - Method of Measuring Squareness of Bearings

(2) If the left hand point of the gauge rests against the bearing bracket, neither of the two right-hand, diametrically opposite points of the gauge shall clear the bracket by more than .004". If one of the diametrically opposite points of the gauge rests against the bearing bracket, the other of these two points shall not clear the bracket more than .008" and the left-hand point of the gauge shall not clear the bracket by more than .004".

(3) If the clearance is not satisfactory, realign the bearing as follows: Loosen the bearing bracket mounting screws with the No. 245 or 305 wrench and adjust the aligning screws as required with the 4" regular screwdriver.

(4) When the bearing bracket has been adjusted satisfactorily, tighten the bracket mounting screws securely.

(5) After tightening these screws, recheck the bearing bracket for squareness as covered above.

(6) 10 Type and Graphalloy Bearings, Except the No. 13A Bearings: Adjust the 10 type and graphalloy bearings except the No. 13A bearings in accordance with (3) or (4) above.

(7) No. 13A Bearings: (No procedure)

3.12 Starting Torque Test (Rq.2.12)

(1) Before dismounting any apparatus to make tests or readjustments for torque, check the shaft for straightness as outlined in 3.06-3.07.

(2) Before making the torque test, remove the coupling connecting the vertical drive shaft and the vertical shaft of the drive as follows.

(3) Where an eccentric coupling is used note where the distance between a driving disc and the upper surface of the bearing bracket nearest a driving disc is less than 1/4" and insert the R-1994 wedge at this point as shown in Fig. 26. Remove the coupling as outlined in 3.16 to 3.19 inclusive. In cases where the rigid type coupling is used, loosen the coupling clamping screws with the No. 254 socket wrench.

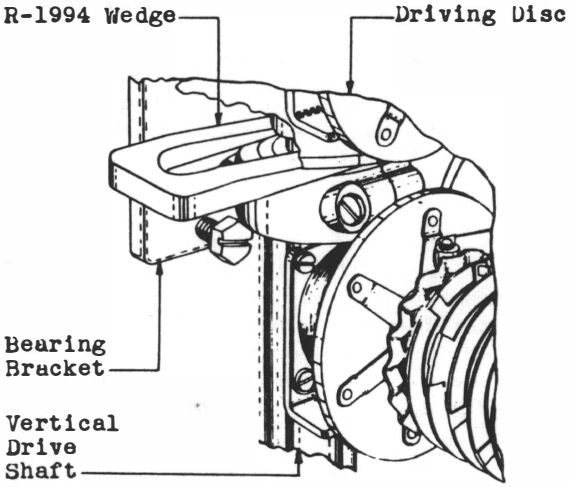

Fig. 26 - Method of Supporting Vertical Drive Shaft

(4) Then place the No. 427A shaft supporting tool between the bottom of the vertical drive shaft and the top of the vertical shaft of the drive. If there is any clearance between the shafts and the tool, insert a sufficient number of blades of the No. 74D thickness gauge between the bottom of the tool and the vertical shaft of the drive to take up the clearance as shown in Fig. 27. Allow the weight of shaft to rest on the gauge. After the shaft has been supported satisfactorily, remove the R-1994 wedge.

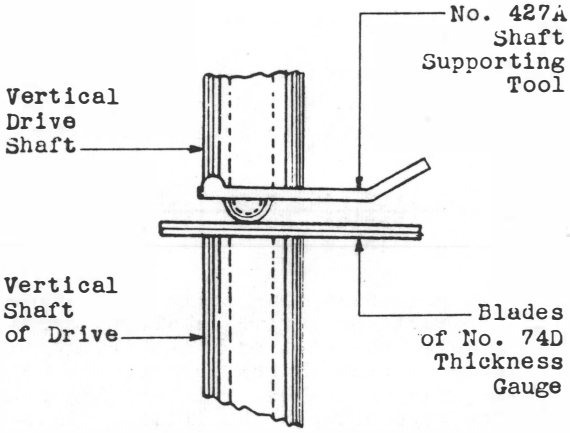

Fig. 27 - Method of Using the No. 427A Tool When Checking Starting Torque

(5) To make the torque test proceed as follows: If the driving discs have filister head clamping screws, hook one end of the R-1313 fish line over the clamping screw of a disc just above or below a bearing and about four feet from the floor and wind several turns of the line around the vertical drive shaft without crossing by rotating the shaft backward. If, however, the driving discs are secured to the shafts by Bristo set screws proceed as follows: Place a piece of fish line around the shaft just above or below a bearing and wind several turns of the line around the vertical shaft by rotating the shaft backwards. Four or five turns of the line should be wound over the end of the line to prevent it from slipping and then an additional four or five turns should be wound around the shaft without crossing or overlapping. Then attach the No. 79E push-pull tension gauge to the loose end as shown in Fig. 28.

(6) Test by starting and stopping (approximately 20 times per revolution) from the point of greatest friction in three complete revolutions of the shaft in its normal direction. If the starting torque at any point does not exceed the amount specified, the vertical drive shaft and the bearing alignment can be considered satisfactory and no further check for alignment should be made. If the starting torque exceeds this requirement lubricate the ball bearings as outlined in 3.02 and repeat the starting torque test. If the starting torque at any point still exceeds this requirement after being lubricated, the operation of the shaft should be considered unsatisfactory and the source of the bind removed by realigning the shaft and bearings if they are not in satisfactory alignment or by locating and replacing a bearing having a bind. To detect a binding bearing proceed as follows.

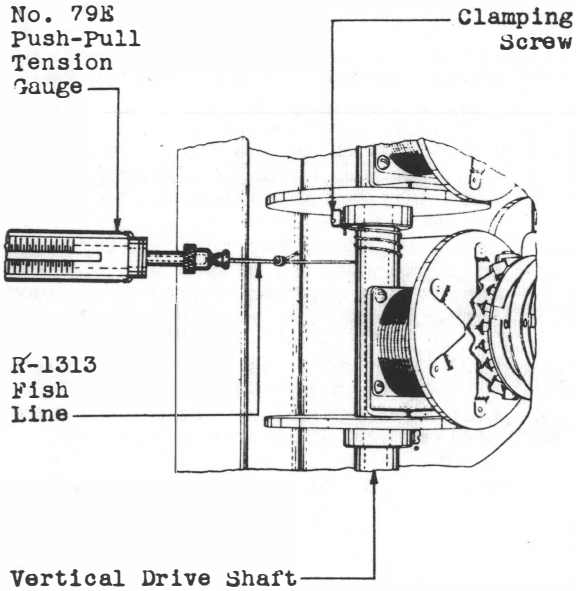

Fig. 28 - Method of Measuring Starting Torque

(7) Ball Bearings: Beginning at the top or bottom bearing, loosen the bearing bracket cap screws with the 4" regular screwdriver and if necessary remove the cap and allow the ball race to assume its natural position.

(8) Check the starting torque immediately with the No. 79E gauge to determine whether or not the bind has been relieved. If not, retighten the cap screws as this bearing is not the source of the bind.

(9) Test all bearings in this manner and in order starting from the top or bottom until the bearing is found which is causing the bind. After locating a bind in a bearing make tests to determine whether it is due to a bind in the ball unit, to the bracket not being mounted square with the shaft or to the manner in which the bearing is clamped in the bracket.

(10) With the cap removed, a bind in the bearing ball unit can usually be detected by turning the ball unit with the fingers. An inspection should be made at this time for broken balls and to determine if the bearing has been properly lubricated. If it is definitely determined that the trouble is due to

a bind in the ball unit, when it is clamped in the bearing bracket, replace the bearing as outlined in the section covering this apparatus.

(11) If the bearing appears to be in good condition replace the retaining washers and bearing cap, setting the screws up tight, and repeat the torque test for bind.

(12) Graphalloy Bearings: Beginning at the top or bottom bearing, loosen the bearing cap screws with the 4" regular screwdriver and while rotating the shaft by hand, tap the bearing bracket with the handle of the screwdriver to assist the bushing to reach a good alignment with the shaft.

(13) Check the starting torque immediately with the No. 79E gauge to determine whether or not the bind has been relieved. If not, retighten the cap screws in accordance with 3.07 as this bearing is not the source of the bind.

(14) Test all bearings in this manner and in order, starting from the top or bottom of the shaft until the bearing is found which is causing the bind. With the bearing cap loosened as outlined above, continue to rotate the bushing to various positions about the shaft and make tests to determine whether or not the torque test is being met. If the torque test cannot be met by adjusting the bushing, replace the bushing with a new one as outlined in the section covering this apparatus. If the torque requirements are still not met, it is a probable indication that the shaft is bowed or that the bearings are not in alignment. In such cases, realign the bearings or straighten the shaft as required as outlined in 3.06, 3.07 and 3.11 respectively.

(15) After correcting any binding bearings, insert the R-1994 wedge as outlined in (3) and remove the No. 427A shaft supporting tool if it has been used. On shafts equipped with rigid couplings securely tighten the coupling clamping screws with the No. 254 socket wrench and on shafts equipped with eccentric couplings, reassemble the coupling as outlined in 3.16 to 3.19 inclusive.

(16) If an eccentric coupling has been used, reassemble the upper half of it by placing the two upper or driven lugs in position so that they engage the slots in the plates and then insert the screws loosely. The flat edges of the clamping portions of the coupling must be down. See 3.16 to 3.19 inclusive for further information regarding the assembling of the coupling.

(17) If any interrupter gears or sequence switches have been moved before making the torque test, restore them to their former positions and adjust them in accordance with the section covering the apparatus.

3.13 Position and Grip of Clamping Collar or Clamping Nuts (10 Type Bearings) (Rq.2.13)

(1) A loose spring collet may allow the vertical drive shaft to drop and change the position of the driving discs with respect to the pole pieces of the sequence switches. If the majority of the gaps between the driving discs and pole pieces are unsatisfactory, proceed as outlined in 3.21. If the majority of the gaps are satisfactory, proceed as outlined in (2) and (3).

(2) If the bearing is equipped with a clamping collar, loosen the clamping collar screws with the 4" regular screwdriver. Place the No. 347 spanner wrench in the slots of the collet and securely tighten the collar with the No. 346 spanner wrench as shown in Fig. 29. Then tighten the clamping collar screws.

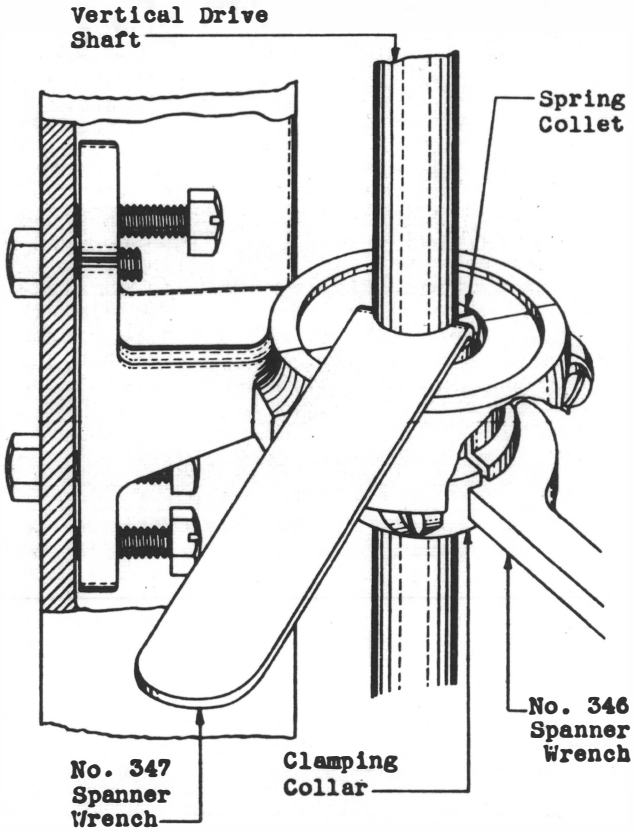

Fig. 29 - Method of Tightening the Clamping Collar of 10 Type Bearings

(3) If the bearing is equipped with clamping nuts, hold the collet with the No. 347 spanner wrench and loosen the lock nut with the No. 247 wrench and tighten the clamping nut securely with the No. 232 wrench. Then securely tighten the lock nut.

3.14 Location of 10 Type Bearing In Its Housing (Rq.2.14)

(1) The upward movement of the shaft may be reduced by locating the ball bearing against the under surface of the upper washers adjacent to the ball bearings. Due to differences in the design of 10 type bearings the procedures for removing the play inside the housing will differ with different types. Where 10 type bearings are used on shafts associated with sequence switches or selectors the air gaps between the driving discs and heelpieces of the associated apparatus should be checked and if satisfactory retained as outlined in (2) and the bearing relocated as outlined in (2) or (3). Where the 10 type bearings are used on shafts associated with interrupters, the position of the shaft should be retained by checking the alignment of the gears before and after relocating the bearing as outlined in (2) or (3) instead of using the 85 type gauge. If the air gaps between the parts or the alignment of the gears is not satisfactory, the apparatus should be readjusted as outlined in the section covering the apparatus involved before relocating the 10 type bearing.

(2) Where the bearing is equipped with a clamping nut and lock nut: Insert an 85 type gauge that fits snugly between the reference disc (if furnished or if not, a disc just above the 10 type bearing) and the associated heel-piece. Hold the collet in place with the No. 347 spanner wrench and back off the lock nut with the No. 247 wrench, until the nut is slightly underflush with the threaded portion of the collet. Then while still holding the collet with the No. 347 spanner wrench, loosen the clamping

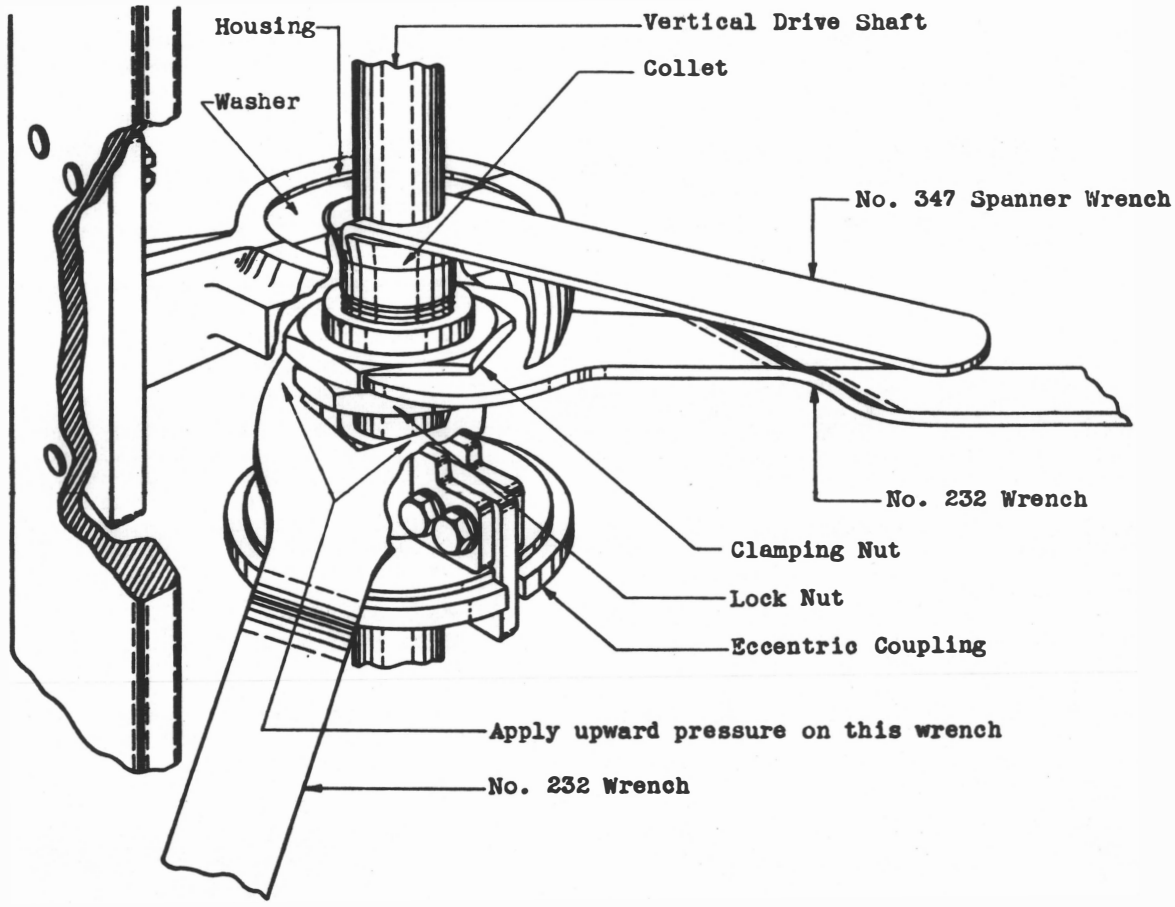

Fig. 30 - Method of Removing Vertical Play From 10 Type Bearing

nut just sufficiently with the No. 232 wrench so that axial movement of the collet along the shaft is permitted. With the clamping nut so loosened there may be a tendency for the vertical drive shaft to drop, particularly where the other bearings on the shaft are equipped with graphalloy bushings. In any case, note whether the gauge is still held snugly in position. If it is not, raise and hold the shaft in its proper position while proceeding as follows. Place a No. 232 wrench against the under surface of the lock nut with the two diagonals of the nut being spanned by the jaws of the wrench as shown in Fig. 30. Exert an upward pressure against the nut and push the ball bearing up against the upper washers of the bearing until the load is taken by the housing. Then while one man holds the bearing and, if necessary, the shaft in position, another man should tighten the collet securely in place using the No. 347 spanner wrench and another No. 232 wrench. Take care in doing this not to apply a downward pressure on the spanner wrench. Remove the No. 232 wrenches and tighten the lock nut in position with the No. 247 wrench. Remove the gauge and check that satisfactory air-gaps between the driving discs and heel pieces have been retained.

(3) Where the Bearing is Equipped with a Clamping Collar and Screws: Proceed as outlined in (2) to make sure that the gaps are retained during the following procedures. Loosen the clamping collar screws with the 4" regular screwdriver. Hold the collet in place with No. 347 spanner wrench and loosen the clamping collar with the No. 346 spanner wrench sufficiently to permit axial movement of the collet on the shaft. Check that the gauge is still held snugly in position as outlined in (2). Place 4" regular screwdrivers on each side of the collet under the clamping collar. Exert an upward pressure against the collar and push the ball bearing up against the upper washers until the load is taken by the housing. Take care in doing this that the screwdrivers do not slip off the clamping collar. Then while one man holds the bearing and, if necessary, the shaft in position, another man should tighten the collet securely in place using the No. 346 and 347 spanner wrenches. In doing this the clamping collar will have to be tightened while it is still being held by the screwdrivers. Take care in tightening the collar not to apply a downward pressure on the No. 347 spanner wrench. Remove the wrenches and screwdrivers and tighten the clamping screws with the 4" regular screwdriver. Remove the gauge and check that satisfactory air-gaps between the driving discs and heel pieces have been retained.

3.15 Location of Adapters and Graphalloy Bushing (Rq.2.15)

(1) If the adapters or bushings are not satisfactorily located, loosen the bearing cap screws with the 4" regular screwdriver and proceed as follows:- To locate the adapters place the 4" regular screwdriver in one of the slots and while holding the bushing in place with the fingers force the adapters to their proper position. To locate the bushing hold the adapters in position with the fingers of one hand, insert the 4" regular screwdriver in the saw slots and push the bushing to the proper position. Then securely tighten the bearing cap screws.

Eccentric Couplings

3.16 Axial Alignment of Shafts (Rq.2.16)
3.17 Clearance Between Shafts (Rq.2.17)
3.18 Engagement of Coupling (Rq.2.18)
3.19 Coupling Adjustment (Rq.2.19)

(1) General: If the eccentric coupling is equipped with a coupling guard, it will be necessary to remove the guard before checking any adjustment. Before removing the guard, note where the distance between a driving disc and the upper surface of the bearing bracket nearest a driving disc is less than 1/4" and insert the R-1994 wedge at this point to prevent the shaft from dropping. Loosen the coupling guard clamping screws with the 3" cabinet screwdriver. Take care in removing the screws not to burr them. Remove any sealing compound from the screws by scraping them with the R-1060 putty knife or cleaning them with a small stiff typewriter brush after they have been soaked in trichloroethylene.

(2) To remove the coupling guard, place the 4" regular screwdriver against the guard so that one corner of the blade rests on the underlapping surface of the coupling guard and against the overlapping edge of the other half of the guard while the other corner against the No. 100A adapter or No. 5A drive hub, as furnished, and the side of the screwdriver blade rests against the edge of the cut-out in the lip of the guard. Then, while exerting pressure on the end of the screwdriver handle, turn it in a counter-clockwise direction, gradually forcing the coupling apart as shown in Fig. 31.

Caution: Before attempting to loosen the eccentric coupling guard be sure that the corner of the screwdriver rests against the No. 100A adapter or No. 5A drive. If this is not done, the clamping collar which is riveted to the guard may be pried off when pressure is applied.

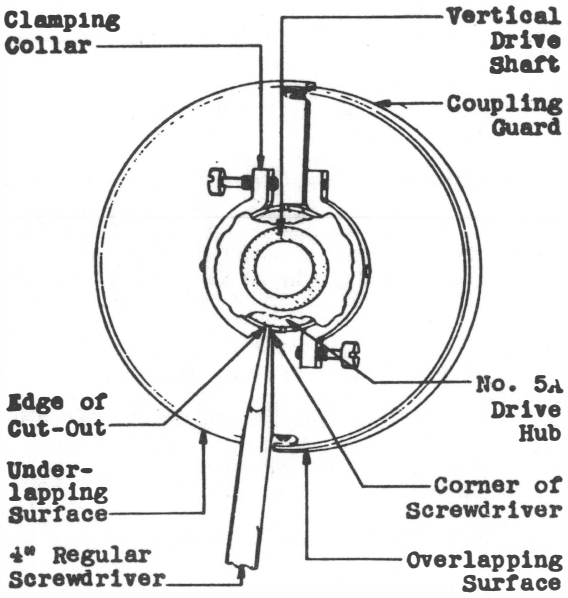

Fig. 31 - Method of Breaking Seal on Eccentric Coupling Guard

After removing the coupling guard from the shaft the compound used in the old seals must be thoroughly removed by either scraping it with the putty knife or by wiping the guard with D-98063 cloth moistened with trichloroethylene. Remove any burrs on the surfaces to be sealed with the R-1051 pillar file.

(3) Remove the sealing compound from between the driving disc or the No. 100A adapter and the coupling guard.

(4) If the eccentric coupling clamping screws have slotted heads, remove the screws with the 4" regular screwdriver; if the screws have hexagonal heads, remove them with the KS-6263 wrench. Remove the clamping lugs, clamping portions and washers.

(5) Axial Alignment of Shafts: To determine whether or not the vertical drive shaft is more than 3/32" out of alignment with the vertical shaft of the drive, place the R-5320 axis alignment gauge on the vertical shaft of the drive with the clearance end up as shown in Fig.32.

(6) Make a number of complete turns of the vertical drive shaft with the gauge mounted on the vertical shaft of the drive being revolved a complete revolution in the opposite direction. If the gauge clears the vertical drive shaft in all positions the two shafts are within the 3/32" requirement.

(7) If, when the shafts are revolved, the vertical drive shaft touches the gauge at any point, determine whether or not the vertical drive shaft is bent.

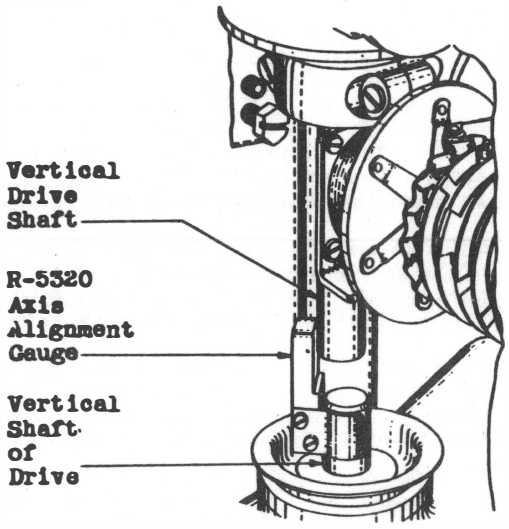

Fig. 32 - Method of Checking for Axial Alignment of Shafts

(8) If the vertical drive shaft is not bent or if after it is straightened in accordance with the procedures outlined in 3.10, the gauge continues to show misalignment at any point, it is an indication that the shaft must be realigned in order to meet the 3/32" requirement.

(9) If necessary to realign the shaft to meet the above requirements move it to either one side or the other to favor the above condition and so allow the indicator pointer of the No. 120A or No. 159A gauge (depending on whether sequence switches or power driven rotary selectors are mounted on the frame) to rest within the limit lines on the scale by adjusting the bottom bearing as outlined in 3.06-3.07. In the case of shafts associated with gear reduction drives, determine whether the drive is in proper alignment as outlined in the section covering this apparatus.

(10) If the bottom bearing has been relocated it will be necessary to check the alignment of the other bearings on the shaft as outlined in 3.06-3.07.

(11) As previously stated in the adjusting procedures for the other bearings covered in this section the bearing must be adjusted to meet 2.11 for squareness of bearing at the time it is aligned.

(12) Clearance Between Shafts: If the clearance between the vertical shaft of the drive and the vertical drive shaft is not satisfactory, it will be neces-

sary to raise or lower the vertical drive shaft. Where the shaft is equipped with a 10 type bearing, it will be necessary to loosen the thrust collar on the shaft as outlined in 3.13 before raising the shaft. The shaft may be raised by using the R-1994 wedge to lift the shaft up through the bearings the required amount. If the shaft cannot be raised enough in this manner to meet the requirement saw off a piece from the bottom of the shaft taking the necessary precautions to catch the particles removed from the shaft.

(13) In making the above adjustment take care that the requirement covering coupling engagement will be met when the coupling is completely assembled.

(14) On shafts associated with sequence switches and power driven rotary selectors, check that the heel gap requirement as covered by the section covering the apparatus and 3.14 and 3.21 of this section is satisfactory before clamping the 10 type bearing securely in place or reassembling the eccentric coupling.

(15) If necessary, clean the eccentric coupling as outlined in 3.01. Before reassembling the eccentric coupling, examine the slot in the steel plate to see whether there are any rough surfaces. Rough surfaces in these slots cause wear on the driving lugs and cause jerky operation of the coupling which may result in false operation of the sequence switches. Where the sides of the slots are rough or badly tool scratched, smooth the surfaces with No. 00 carborundum paper wrapped around a flat piece of wood about 1/8" thick. It is not necessary to completely remove all tool marks. Fifteen or twenty strokes of the tool are usually sufficient to remove all objectionable burrs. Unless there are raised portions or burrs, slight indentations or tool marks are not objectionable as they serve as lubrication carriers. After using the No. 00 carborundum paper, wash the part off thoroughly with KS-7860 petroleum spirits to remove all the carborundum particles.

(16) Slide the upper bronze plate, the steel plate and the lower bronze plate in the order named, up onto the vertical drive shaft. When the clearance between the shafts is not enough to slip the steel driving plate between them, it will be satisfactory to remove the caps from the two lower drive shaft bearings and to spring the vertical drive shaft sufficiently to admit the center disc of the coupling when tipped up on edge. Lubricate the coupling as outlined in 3.02.

(17) Place the two bottom clamping portions over the vertical shaft of the drive in such a way that the pin in one of the clamping portions engages the slot or hole in the vertical shaft of the drive on the rear side. The straight edge of the clamping portion should be up.

(18) Place the lower bronze plate over the vertical shaft of the drive, so that the plate is parallel with the clamping portion of the coupling. Place the steel plate on the lower bronze plate in a position in which the slots in the plate coincide. Place the upper bronze plate on the steel plate at right angles to the lower bronze plate.

(19) Place the two lower driving lugs in position so that they engage the slots in the plates and then insert their screws loosely.

(20) Place the .003" blade of a No. 74D thickness gauge between the top bronze plate and the under side of the hooked portions of the driving lugs on each side of the coupling. This is to provide clearance between the bronze plate and the driving lugs. Before tightening the clamping screws, see that the inner end of the driving lugs are firmly against the shaft or as close to the shaft as possible and with the inner surfaces of the lugs parallel with the shaft. Press the coupling down hard on the washers, press the lugs against the blade of the No. 74D thickness gauge and tighten the outer screws first, then tighten the inner screws and repeat the operation in this order until the screws are as tight as practicable.

(21) Repeat the operation previously described in assembling the upper half of the coupling. The flat edges of the clamping portions of the coupling must be down. The position of the driven lugs will be reversed to that of the driving lugs. Place the blade of the No. 74D thickness gauge between the under side of the lower bronze plate and the hooked portion of the driven lugs. Press the clamping portions down on the bronze plate and press the driven lugs toward the vertical drive shaft and tight against the blade of the thickness gauge, when the clamping screws are being tightened. Tighten the outer clamping screws first as previously described.

(22) To check the gaps between the driving and driven lugs and the bronze plate, proceed as follows: rotate the motor coupling by hand through one complete revolution of the eccentric coupling and observe the gap between one lug and the bronze plate through the entire revolution. Note the point where the

gap is the smallest and attempt to insert the .004" blade of the No. 74D gauge between the lug and the plate. If the blade cannot be inserted in the gap, the lug is satisfactorily adjusted. If it can, readjust as outlined above. Then check, and if necessary, readjust the gaps between the other lugs and the bronze plate.

(23) Before mounting the coupling guard, apply the KS-6824 sealing compound to the coupling guard as outlined in 3.20 and to the oil guard as outlined in the section covering friction roll drives.

(24) After the coupling guard is reassembled on the shaft, remove the R-1994 wedge.

3.20 Mounting of Eccentric Coupling Guard (Rq.2.20)

(1) General: If the vertical clearance between the bottom edge of the eccentric coupling guard and the upper edge of the oil guard is not satisfactory, it is probably due to the location of the clamping guard on either the No. 5A drive hub or the No. 100A adapter or to the position of the adapter on the vertical drive shaft. In any case, remove and clean the eccentric coupling guard as outlined in 3.16 to 3.19 inclusive.

(2) Before using the KS-6824 sealing compound stir it thoroughly with a flat piece of hard smooth wood just before using it. Make sure that the surfaces to be sealed are thoroughly dry and free from oil before applying a liberal coat of the sealing compound. Apply the compound with the R-1021 brush. When the sealing compound is of such a consistency that it cannot be applied easily with the brush, thin it with trichloroethylene. Make up the joints as soon as the compound has been applied to the surfaces to be sealed. When using the compound it is not necessary to allow an interval of time between applying the compound and making up the joints. The pigment or thicker part of the compound does the sealing and the thinner part of the compound is only used as an aid in conveying the pigment of the sealing compound to the surfaces to be sealed.

(3) Dip the screws into the sealing compound before inserting them. When setting up the screws, make sure that the part bears uniformly throughout its entire contact surface. This can be accomplished by making several rounds of the screws in tightening. Do not tighten them completely the first time around.

(4) Coupling Guard Mounted on No. 100A Adapter: Before locating the coupling guard on the shaft, apply the KS-6824 sealing compound to the overlapping surfaces of the guard, the inside surfaces of the lip of the guard and the sides of the No. 100A adapter. Assemble the halves of the guard in place on the shaft and insert the clamping screws in loosely in the opposite half of the guard. Shift the location of the guard on the No. 100A adapter until the upper surface of the collar is flush with the upper surface of the adapter. If the clearance still is not satisfactory, raise or lower the adapter and the guard on the shaft until the requirement is met. After the guard is satisfactorily located, seal the joints between the lips of the guard and the adapter, the slots in the adapter and around the collar which clamps on the adapter. In sealing the slots of the adapter, several applications of the sealing compound may be required before the slots are filled sufficiently to make a satisfactory seal. Then tighten the clamping screws securely and seal the joint between the adapter and the shaft, placing the sealing compound around the joint at the upper surface of the adapter. Wipe off the excess sealing compound with the D-98063 cloth moistened with trichloroethylene before the compound has had time to dry. Then paint the joints with aluminum paint applied with the KS-14164 brush.

(5) Coupling Guard Mounted on No. 5A Drive Hub: Before locating the coupling guard on the No. 5A drive, apply the KS-6824 sealing compound to the overlapping surfaces of the guard, the inside surfaces of the lip of the guard and the sides of the No. 5A drive hub. Relocate the coupling guard on the drive hub so that the vertical clearance between the guard is satisfactory and with the guard overlapping the collar as specified in the requirement. After tightening the clamping screws securely, seal the joint between the drive and the shaft placing the sealing compound around the joint at the upper surface of the drive and seal the joints in the guard as outlined above.

(6) If satisfactory vertical clearance cannot be obtained with the guard overlapping the hub, it will be necessary to use a No. 100A adapter, mounting it as outlined in the section covering this apparatus and seal it as outlined in (4).

3.21 Positioning Vertical Shaft to Meet Requirement Covering Location of Driving Discs

(1) When the section covering sequence switches refers to this section for

procedures for raising or lowering the shaft as a means of obtaining the location of driving discs proceed as follows.

(2) To raise the shaft, remove the coupling guard, if provided, as outlined in 3.16 to 3.19 inclusive. Support the vertical drive shaft by inserting the R-1994 wedge between the bottom surface of the hub of the lowest driving disc on the shaft or the bottom of the No. 100A adapter and the top edges of the two upper clamping portions of the eccentric coupling as shown in Fig. 33.

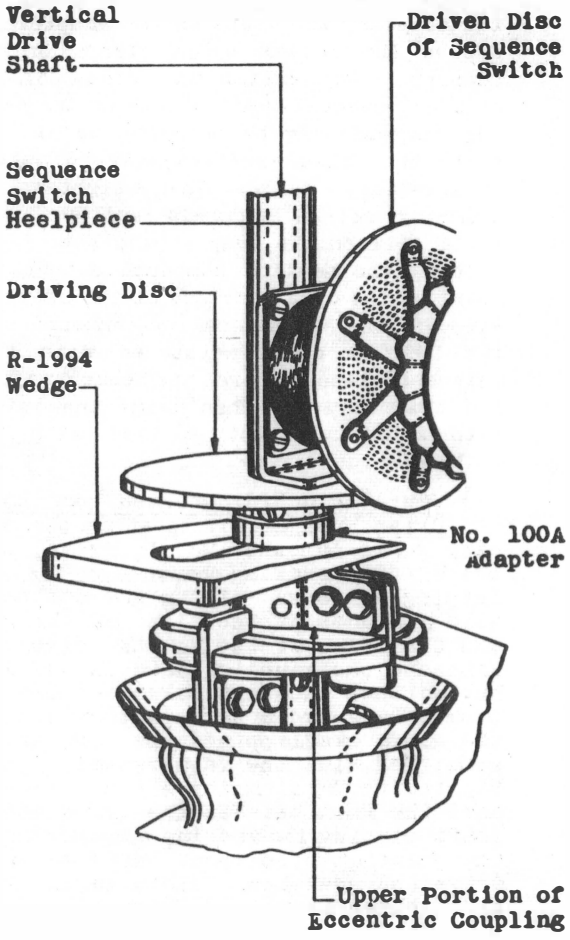

Fig. 33 - Method of Supporting Vertical Drive Shaft While Eccentric Coupling Clamping Screws Are Loose

(3) Where space between the hub on the lowest driving disc and the eccentric coupling is greater than 1/4", it will be necessary to lower the driving disc to permit the application of the wedge. In the event that the space between the hub of the disc and the eccentric coupling is insufficient to permit the application of the wedge, insert the wedge between a driving disc and a bearing as outlined in 3.16 to 3.19 inclusive. On frames not equipped with a driving disc beneath the lowest bearing, a clamp may be made by securely mounting two eccentric coupling clamping portions on the shaft in place of the driving disc. In doing this assemble the clamping portions on the shaft with the long straight sides toward the eccentric coupling.

(4) If the bottom bearing is a 10 type bearing loosen the clamping collar or clamping nuts as outlined in 3.13.

(5) With the R-1994 wedge in place, loosen the clamping screws on the upper portions of the eccentric coupling with the 4" regular screwdriver or KS-6263 wrench as required. Insert the proper gauge (specified in the section covering sequence switches) between the preselected driving disc and pole piece. Push the R-1994 wedge in until the gauge is friction tight. Securely tighten the clamping screws and remove the wedge and the gauge. Securely tighten the 10 type bearing on the shaft if it is furnished as outlined in 3.13 and 3.14 and reassemble the coupling guard as outlined in 3.20, and remove the R-1994 wedge.